ENGINEERING

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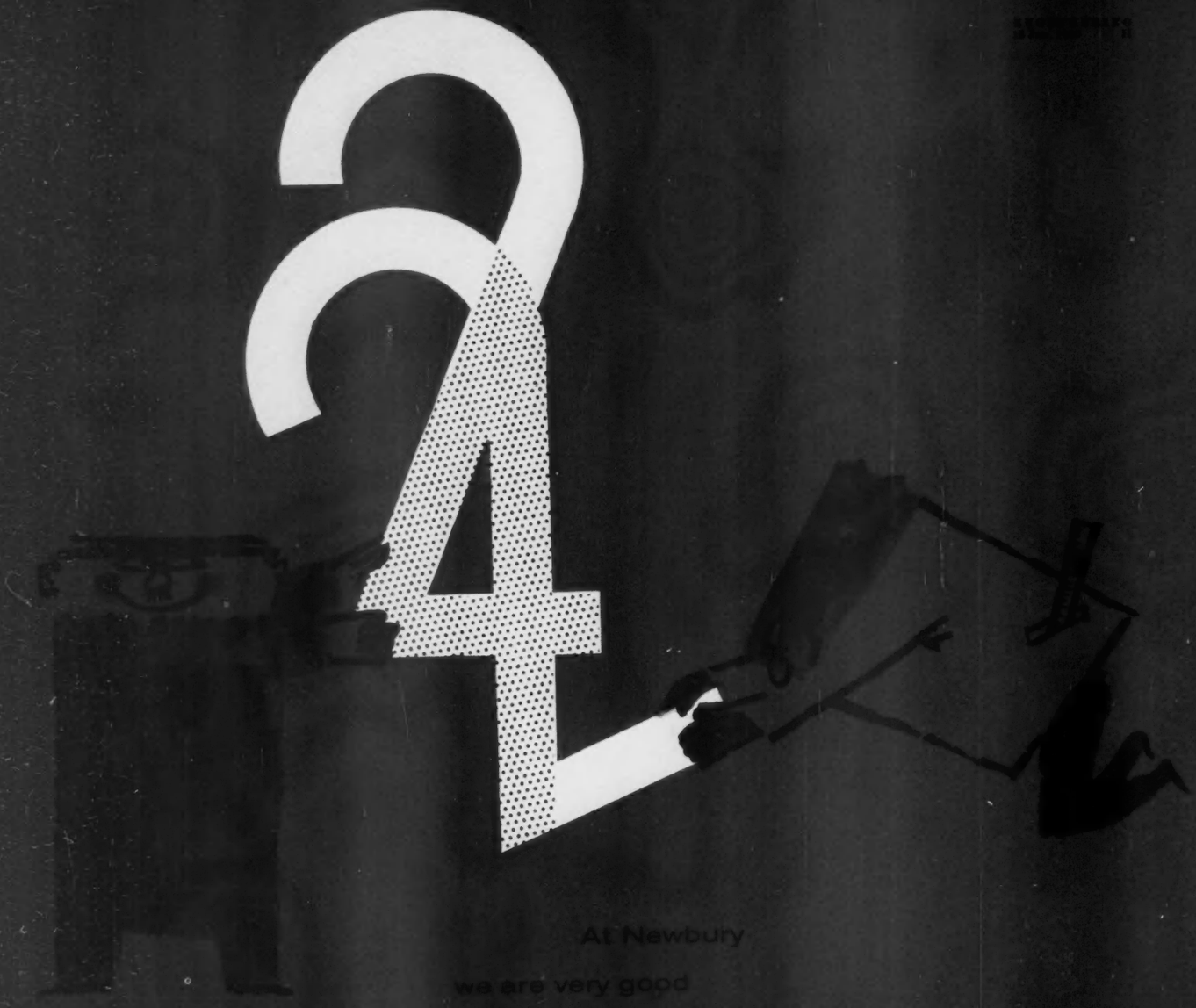

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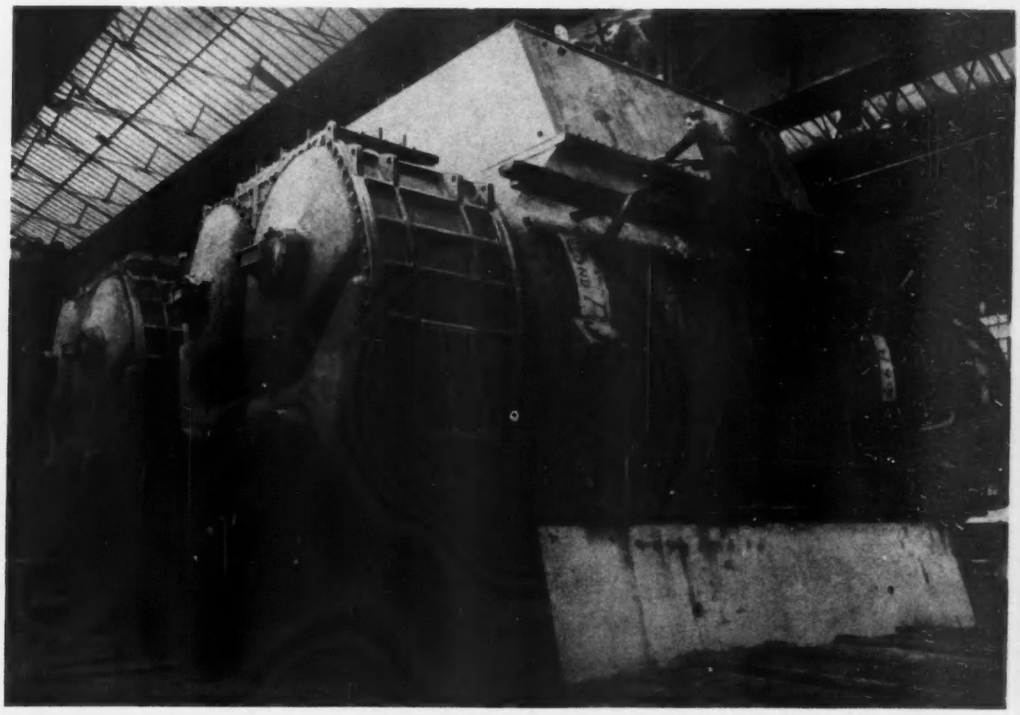

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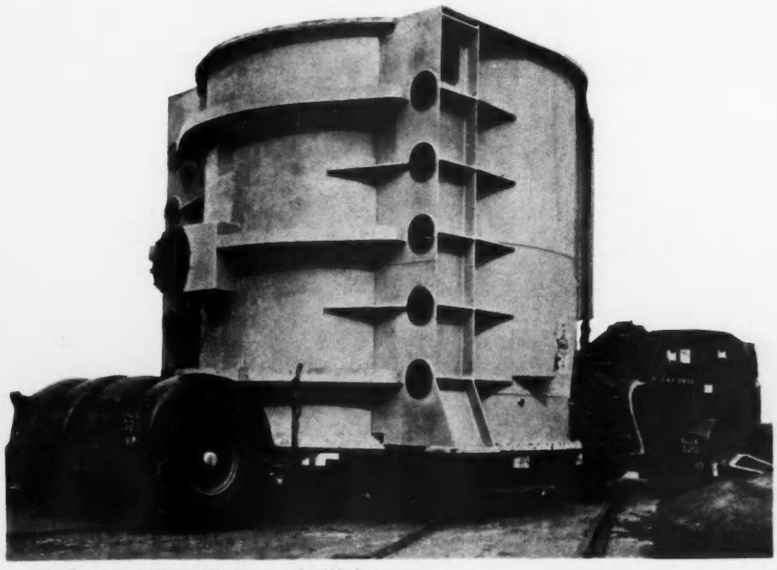

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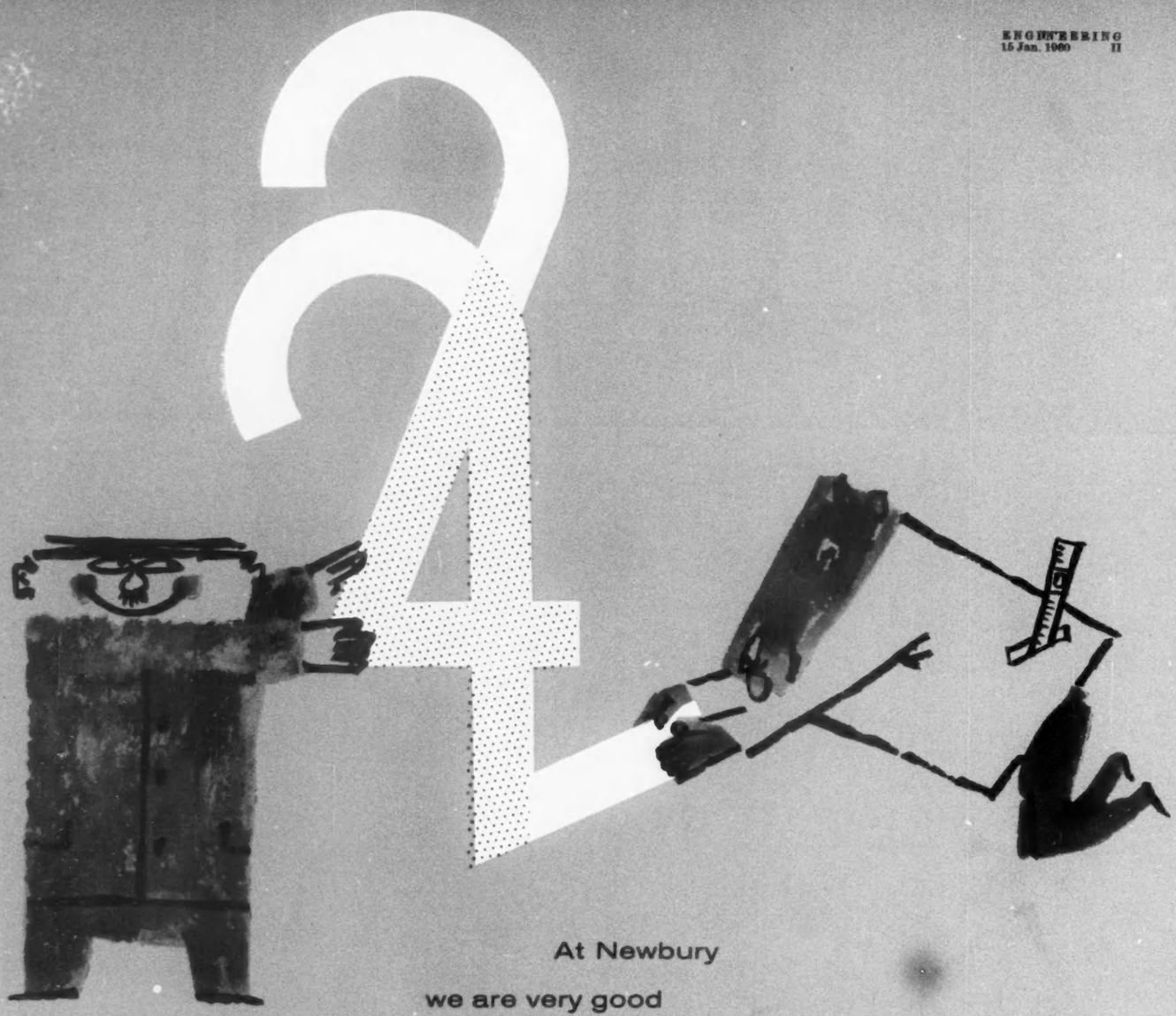

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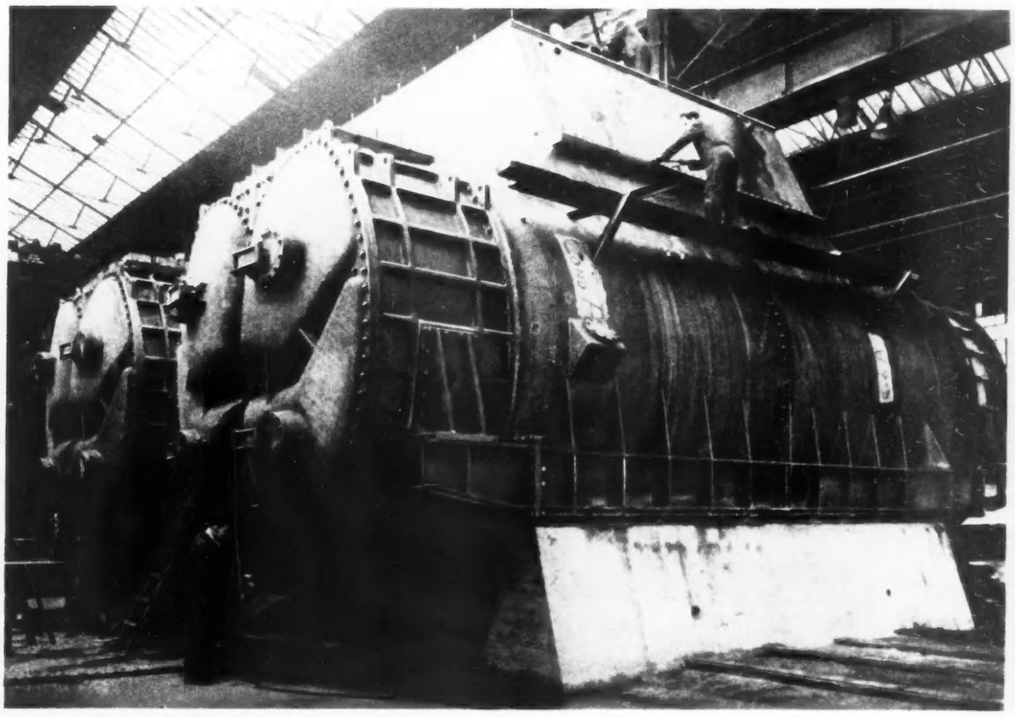

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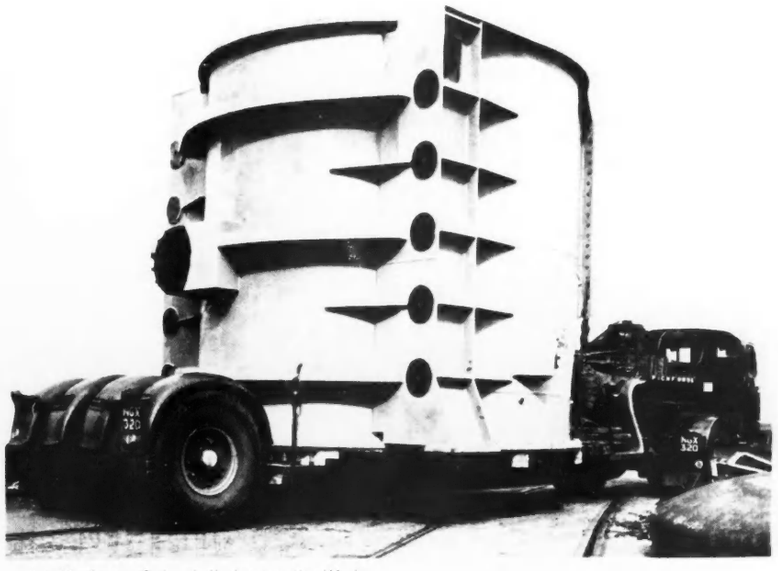

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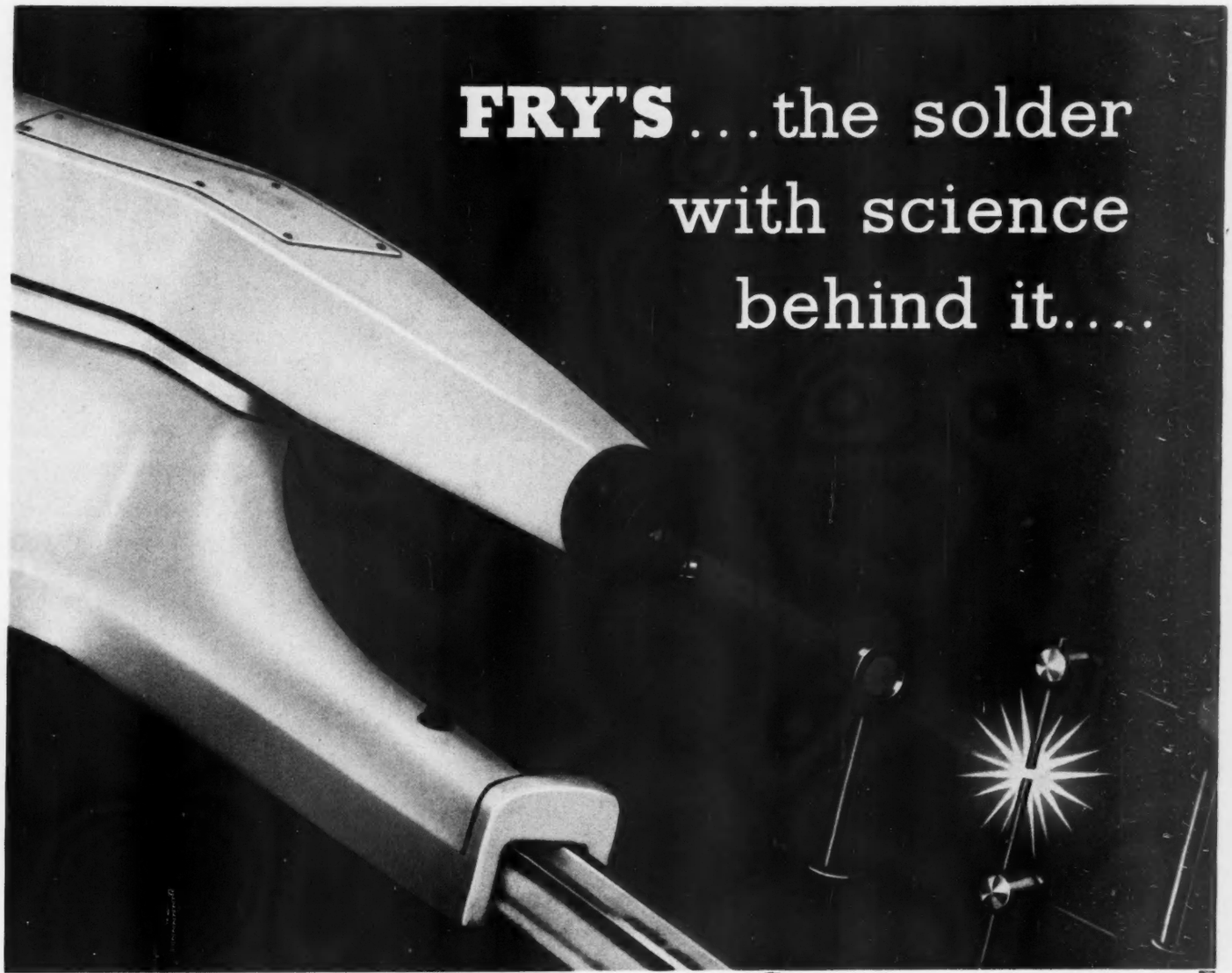

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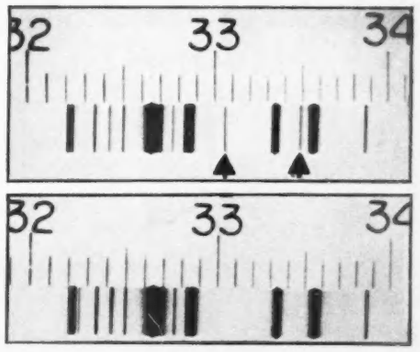

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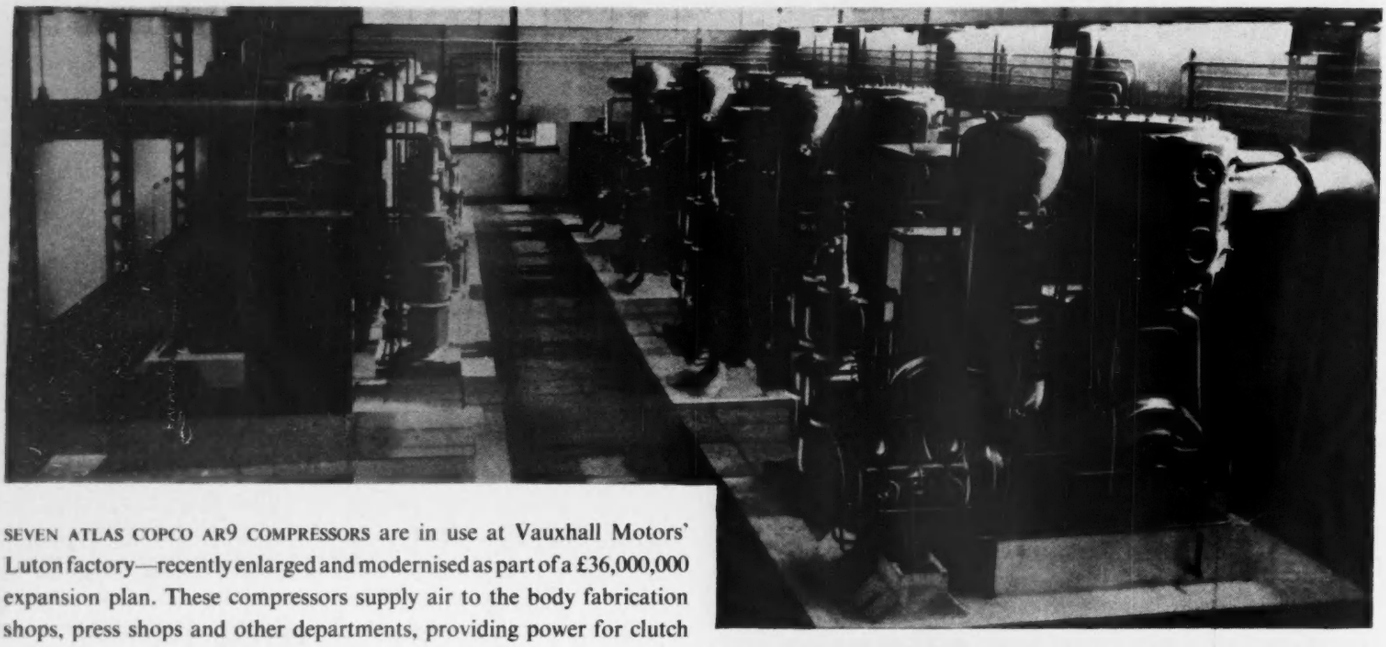
Compressed Air at work in Vauxhall's Luton extension



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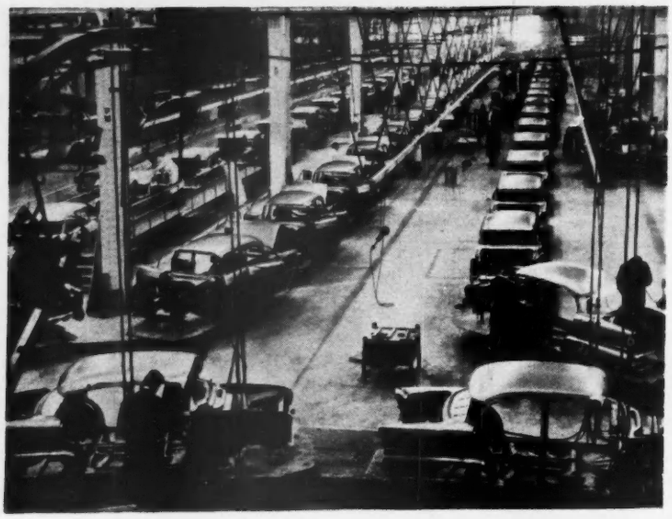

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15 January 1960

Vol. 189 No. 4891

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone : Temple Bar 3663

Contents

74 Metals and Materials

Making New Metals Ductile and Massive: Titanium Mastered, Ductile Molybdenum, Massive Tungsten, Tantalum and Niobium Need Careful Handling, Promising Platinum Metals, Zirconium and Beryllium

78 Construction

Concrete Strength Near Freezing Point
By Dr. J. M. Plowman

Hydroelectric Scheme completed in Turkey, Railways into Roads in Norfolk, Yorkshire Extension to the Motorway, Aluminium Canopy for Circular Building, Research Scholarship in Light Alloys

84 New Plant and Equipment

Closed Quench Furnace, Hacksaw Blade, Engineer's Level, Power Pack, Radiant Heater, Surface Grinder, Hobbing Press, Ultrasonic Cleaner, Signal Generator, Collector Trolley, Induction Heater, Straddle Carrier, Variable Transformer, Bowl Screens, Coil Winder, Arch Press, Sheet Grader, Vibration Meter, Counter Batcher, Time Code Generator, Vibrating Drive Motor, Industrial Motor, Work Table, Hydraulic Mandrel

90 Production

Automatic Production Lines in Russia
By O. Tedder

Grinding Uranium Oxide, Port Capacity Doubled, More Silicon Diodes, New Board-making Machine, Standardised Welding Filters, Production Lines at School, Watches with Unbreakable Springs

92 Operation and Maintenance

Free Piston Gas-Turbine Engines in Use

Taking the Dust out of Dustbins, Move the Goods, not the Workers

97 Design

Lightweight Boom of Honeycomb Construction, Combined Drawing Aid and Pantograph, Picture Page

100 Research and Development

The Technical Problems of Broadcasting: Part 2—Managing the Low Frequencies
By D. E. L. Shorter

New Source of Electrons Discovered

73 Impact

81 Human Element

89 Companies

99 Marketing

Special Articles

82 European Energy Policies in Perspective

102 Outlook 1960—Atomic Energy, Locomotives and Rolling Stock, Aircraft and Engines

80 Automobile Review

British Contribution to Motor Racing

87 Atomic Review

Hydrogen Metamorphosis

108 At Home

No-Draught Fires

76 Plain Words

76 Letters to the Editor

Children of the Sun
By D. J. Grosse

NSU-Wankel Engine
By W. A. Woods

Libraries in India
By R. Radhakrishnan

77 Events in Advance

94 Publications

On the Shelf
By Frank H. Smith

Directory of Opportunities for Graduates, 1959

Directory of Opportunities for School Leavers, 1959

Ken Jones—Electrical Engineer

How to Become a Professional Engineer

Standardisation—What's In It for Me?

Economics for the Mineral Engineer

Introduction to Mining. Vol. 1

New Books and Trade Publications

Cover Picture:

The problems of controlling lubricating oil consumption past piston assemblies is being studied fundamentally at Cambridge University Engineering Laboratories. A motored rig is used for testing different piston designs and lubricating oils. (*Nurnberg photograph for* ENGINEERING)

Subscription Rates: Editorial page 108

Index to Advertisers: Overleaf

Engineering Appointments Section: Faces Editorial page 88

Advertisers in 'Engineering' this week

	PAGE
Accurate Recording Instrument Co., ...	4
Acheson Colloids, Ltd. ..	73
Adamson, J., & Co., Ltd.	60
Amal, Ltd.	10
Armstrong Patents Co., Ltd.	38
Armstrong Stevens & Son, Ltd.	10
Ashmore, Benson, Pease & Co., Ltd. *Wrapper* VIII	
Associated Electrical Industries Ltd.	
Heavy Plant Division	30
Motor & Control Gear Division	81
Transformer Division	46
Atlas Copco A.B. (Sweden) *Wrapper* VI	
Auchterlonie, C., & Co., Ltd.	7
Austin, E., & Sons (London) Ltd. ..	58
Baker Platinum, Division of Engelhard Industries Ltd.	14
Barry, Henry, & Cook, Ltd.	75
Baynes, C., Ltd. ..	10
Blakeborough, J., & Sons, Ltd.	52
Booth, Joseph, & Bros.	53
Braby, F., & Co., Ltd. ..	78
Braithwaite & Co. Engineers, Ltd.	75
Bristol Siddeley Engines, Ltd. .. .. 26 & 79	
British Ermeto Corpn., Ltd.	72
British Geon, Ltd. ..	42
British Steam Specialties, Ltd.	43
Broom & Wade, Ltd. 18 & 19	
Brown, D. Corpn. (Sales) Ltd.	25
Brown, E. G., & Co., Ltd.	15
Brown, N. C., Ltd.	4
Brown, Lenox & Co., Ltd.	5
Brush Electrical Eng'g. Co., Ltd.	8
Carruthers, J. H., & Co., Ltd.	70
Chemical Construction (GB) Ltd.	17
Chesterfield Tube Co., Ltd.	58
Clyde Crane & Booth, Ltd.	53
Clyde Crane & Eng'g. Co.	53
Conveyor & Elevator Co. (1936) Ltd.	10
Cox & Danks, Ltd. ..	21
Crofts (Engineers) Ltd.	35
Crosby Valve & Eng'g. Co., Ltd.	77
Delta Metal Co., Ltd. ..	56
Douglas, Lawson & Co., Ltd.	7
Drummond-Asquith Ltd.	55
East Lancashire Chemical Co., Ltd.	38
Editorial Contents ..	1
"Engineering" Reprints	60
Fairey Engineering, Ltd.	47
Fenter, Ltd.	43
Fescol, Ltd.	36
Firth, Thos., & John Brown, Ltd.	54
Firth Brown Tools, Ltd.	37
Fordsmith, H., Ltd. ..	21
Fry's Metal Foundries, Ltd. .. *Wrapper* V	
Gas Council .. .. 40 & 41	
General Electric Co., Ltd.	56
Godfrey, Sir G., & Partners (Industrial) Ltd.	16
Grafton Cranes, Ltd. ..	80
Green, R., Ltd. ..	87
Greenwich Insulation Co., Ltd. .. *Wrapper* IV	
Guest Keen & Nettlefolds (Midlands) Ltd.	86
Hackbridge & Hewittic Electric Co., Ltd. ..	15
Hawker Siddeley Brush Turbines Ltd. ..	83
Hawker Siddeley Group	45
Head Wrightson Teesdale Ltd.	84
Heenan & Froude, Ltd.	28
Hill Alzen (Sales) Ltd. ..	74
Hockley Foundry Co., Ltd.	28
Hudswell Clarke & Co., Ltd.	15
Hunt Heat Exchangers, Ltd.	2
Imperial Chemical Industries, Ltd.	
Metals Division ..	85
Fibres Division ..	29
Ingersoll-Rand Co., Ltd. 50 & 51	
International Computers & Tabulators Ltd. ..	39
Ironsides Lubricants Ltd.	15
Joy-Sullivan, Ltd. ..	73
Kay & Co. (Engineers), Ltd.	7
Kitchen & Wade, Ltd. ..	76
Lee, A., & Sons Ltd. *Wrapper* VII	
Markland Scowcroft, Ltd.	20
Massey, B. & S., Ltd. ..	69
Mather & Platt, Ltd. ..	24
Mavor & Coulson, Ltd. ..	57
Mek-Elek Eng'g., Ltd. ..	75
Metalastik, Ltd.	65
Micanite & Insulators Co., Ltd.	28
Millspaugh, Ltd.	59
Mobil Oil Co., Ltd. ..	88
Mond Nickel Co., Ltd. ..	49
National Industrial Fuel Efficiency Service ..	43
Newbury Diesel Co., Ltd.	28
Norris Bros., Ltd. ..	15
Opperman Gears, Ltd. *Wrapper* II	
Parsons, C. A., & Co., Ltd.	67
Payne & Griffiths, Ltd.	43
Pegler & Louden, Ltd. ..	14
Pilot Works, Ltd. ..	22
Plenty & Son, Ltd. ..	31
Pool, J. & F., Ltd. ..	82
Power Auxiliaries, Ltd.	69
Power Plant Co., Ltd. ..	76
Power-Gas Group. *Wrapper* VIII	
Priest Furnaces, Ltd. ..	82
Proops Bros., Ltd. ..	75
Randall, J. H., & Son, Ltd.	82
Rawlplug Co., Ltd. ..	9
Reavell & Co., Ltd. ..	4
Reid Gear Co., Ltd. ..	87
Reyrolle, A., & Co., Ltd.	61
Roberts, J. W., Ltd. ..	2
Robertson, W. H. A., & Co., Ltd.	64
Robinson, E. S. & A., Ltd.	34
Robson, G., & Co. (Conveyors) Ltd.	87
Rocol, Ltd.	12
St. Georges Engineers, Ltd.	32
Saunders Valve Co., Ltd.	71
Serck, H. O., Ltd. ..	87
Simplifix Couplings, Ltd.	27
Smiths Industrial Instruments, Ltd.	80
Sones, W. L., & Son ..	14
South Durham Steel & Iron Co., Ltd. ..	33
Stewarts and Lloyds, Ltd.	66
Stillite Products, Ltd. ..	11
Tattersall & Sons, Ltd. ..	10
Taylor & Hubbard, Ltd.	82
Taylor Industrial Clutches	60
Tecalemit, Ltd. ..	62
Technoexport	68
Thompson, John, Conveyor Co.	48
Tonks, J., & Co., Ltd. ..	75
Trist, R., & Co., Ltd. ..	22
Tryco-Designs.	75
Tufnol, Ltd.	13
United Filters & Eng'g., Ltd.	60
Victor Products (Wallsend) Ltd.	15
Visco Eng'g. Co., Ltd. ..	63
Vokes, Ltd.	6
Vulcan Boiler & General Insurance Co., Ltd. ..	32
Waller, G., & Son, Ltd. ..	14
Ward, T. W., Ltd. ..	44
Weir, G. & J., Ltd. *Wrapper* III	
Wellman Bibby Co., Ltd.	76
Wellman Smith Owen Eng'g. Corpn., Ltd. ..	80
Wells, A. C., & Co., Ltd.	21
Westwood, J., & Co., Ltd.	9
Whittle, T., & Sons, Ltd.	4
Woodside Die Sinking Co., Ltd.	23

Classified: Trade & Technical

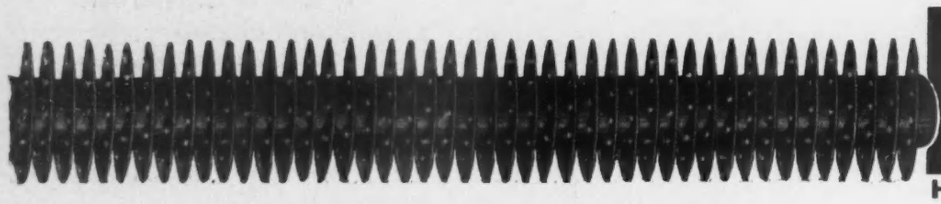
Bell, H. (Machine Tools) Ltd.	3
Dyas & Fowle ..	3
Edwards, F. J., Ltd. ..	3
Flint & Partners, Ltd.	3
Research Engineers, Ltd.	3

'Engineering' Appointments Section Inside Editorial Section

Fairey Aviation Ltd. ..	4
Hawker Siddeley Nuclear Power Co., Ltd. ..	3
Hopkinsons, Ltd.	3
Imperial Chemical Industries, Ltd.	1 & 4
Kellogg International Corp.	4
M.S.L.	5
F. N. Lloyd Co., Ltd. ..	4
Portland Cement Manufacturers, Ltd. ..	3
Turner Bros. Asbestos Co., Ltd.	1

Company Meetings

Hawker Siddeley Group, Ltd.	5
United Steel Companies Ltd.	6



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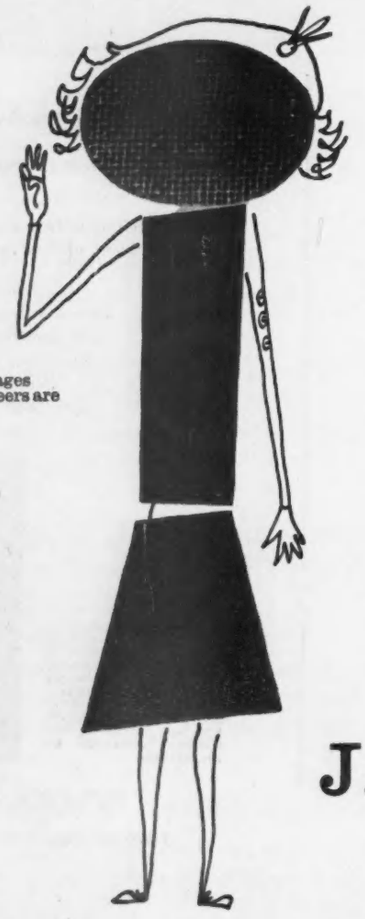

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NIGERIA HOUSE,
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LONDON, W.C.2.

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ELECTRICITY CORPORATION OF NIGERIA,
ELECTRICITY HEADQUARTERS,
13, BROAD STREET,
PRIVATE MAIL BAG 2030,
LAGOS, NIGERIA,
WEST AFRICA.

not later than noon on Wednesday, 10th February, 1960, and should be valid until at least 31st March, 1960. Tenders received in any other manner will not be considered.

The Electricity Corporation of Nigeria does not undertake to accept the lowest or any tender.

Further information concerning this contract may be obtained on application to the Resident Engineer.

C. K. O. ADENAIKE,
ACTING SECRETARY TO THE CORPORATION. B 43

HAMPSHIRE COUNTY COUNCIL
BASINGSTOKE TECHNICAL COLLEGE
PHASE I

TENDERS are invited from suitable suppliers for the **PROVISION OF EQUIPMENT** detailed on the following schedules for the above new college. Suppliers interested may obtain the appropriate schedules direct from the PRINCIPAL, BASINGSTOKE TECHNICAL COLLEGE, and completed tenders are to be returned to the CLERK OF THE COUNTY COUNCIL, THE CASTLE, WINCHESTER, by 10th February, 1960.

Schedule II.—Apparatus, Metrology.
" I.—Furniture, Drawing Offices.
" III.—Apparatus, Physics Laboratories.
" IV.— " Chemistry Laboratories.
" V.— " Biology Laboratory.
" VI.— " Heat Engines Laboratory.
" VII.— " Testing Machines.
" VIII.— " Electrical Machines and Equipment.
" IX.— " Welding Workshops.
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B 56

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12 Special lubricating oils.
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21 Sluice valves, fire hydrants and parts, extension spindles, hydrant indicator plates, etc.
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24 Electric lamps and fluorescent tubes.
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26 Removal of furnace refuse.
27 Photo prints, etc.

Tenders must be submitted on the official forms which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171) or upon forwarding an addressed envelope (not smaller than 15 in. by 10 in.) and enclosing stamps value 1s. 0d. to cover postage, etc.

Applicants should refer to the number of the contract for which tender forms are required.

Tenders, enclosed in sealed envelopes addressed to the undersigned and endorsed in the manner indicated in the form of tender, must be delivered to the office of the Board (Room 122) not later than 12 noon on Thursday, 4th February, 1960.

The Board do not bind themselves to accept the lowest or any tender.

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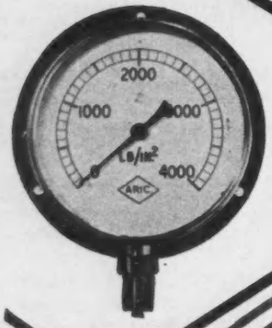

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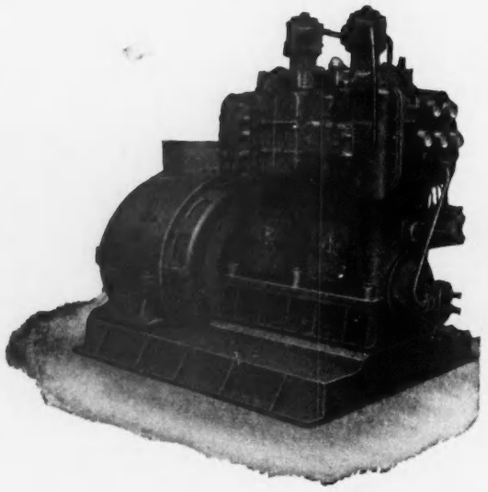

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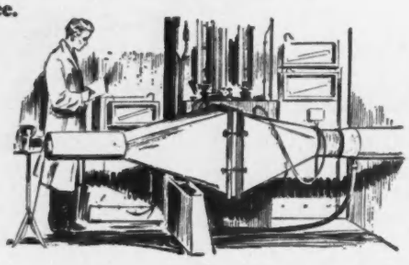

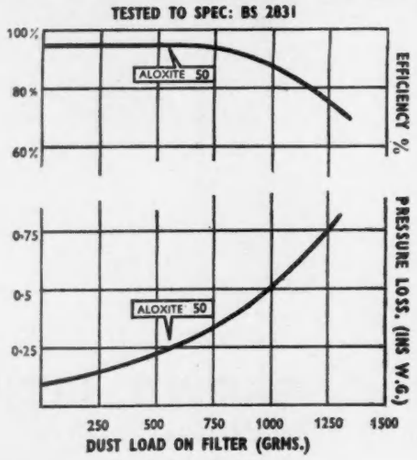

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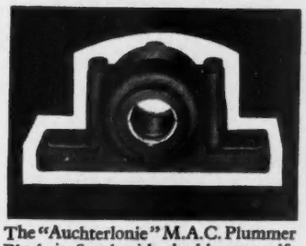

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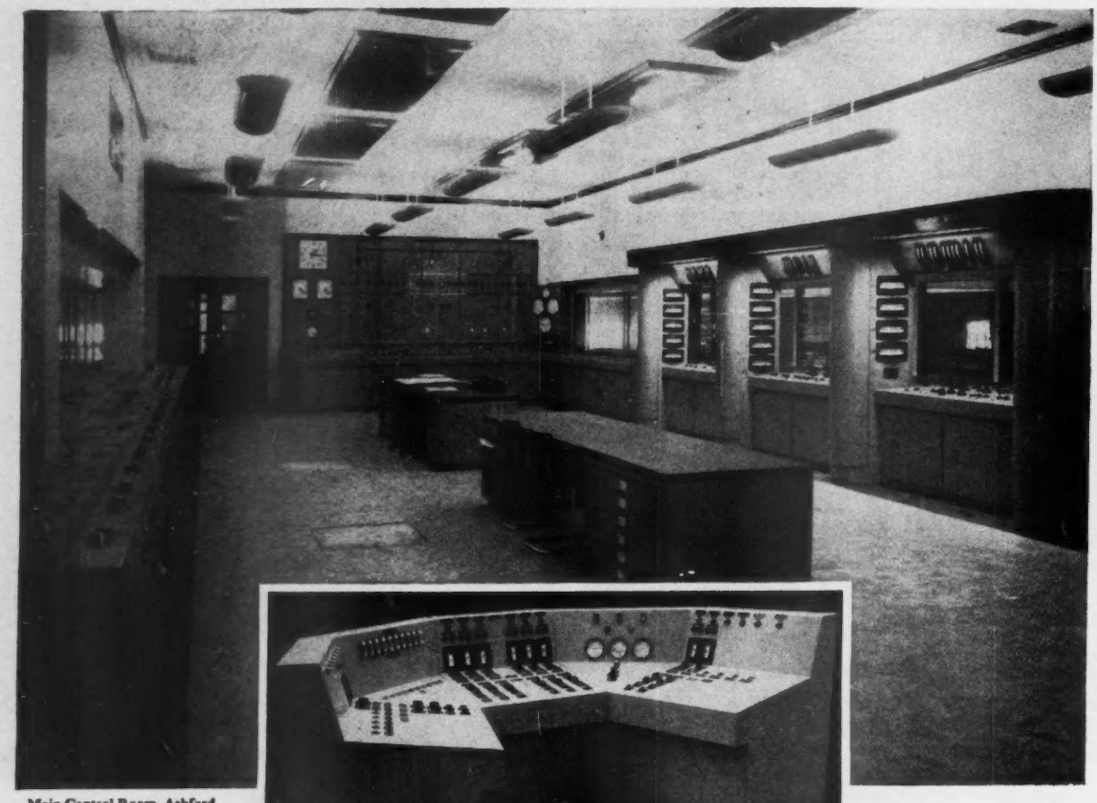

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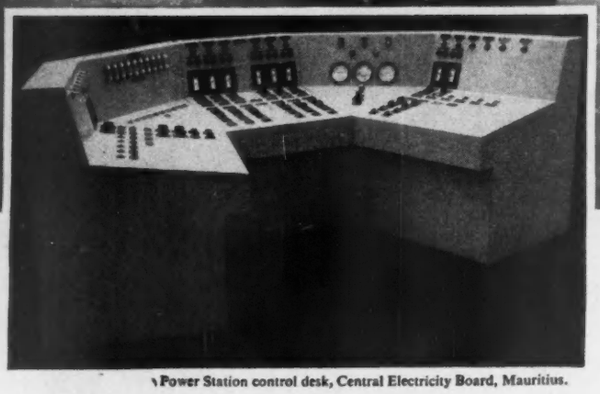

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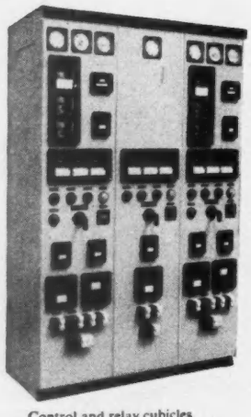

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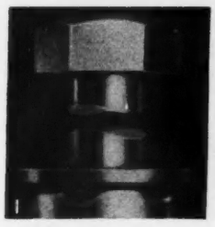

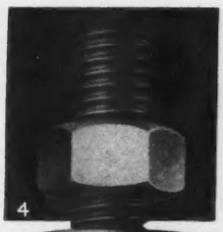

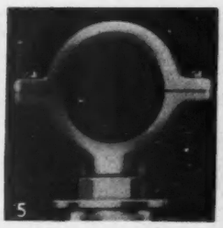

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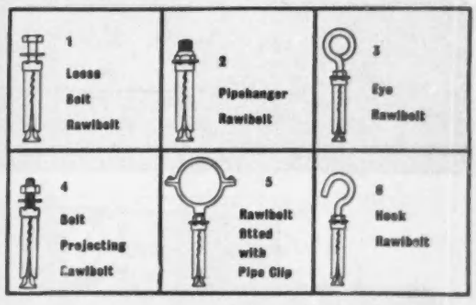

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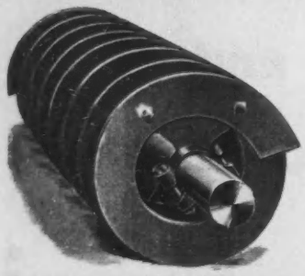

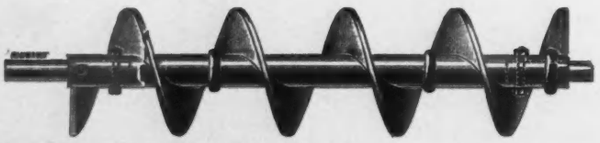

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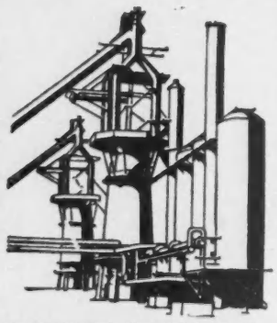

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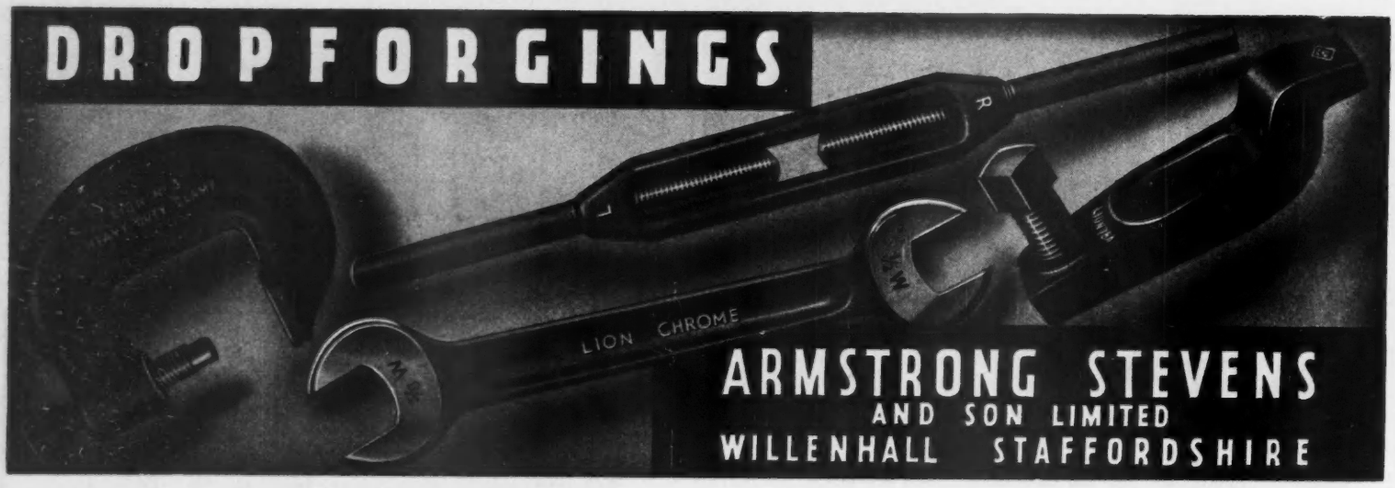

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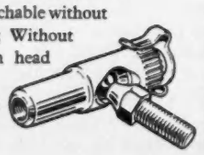

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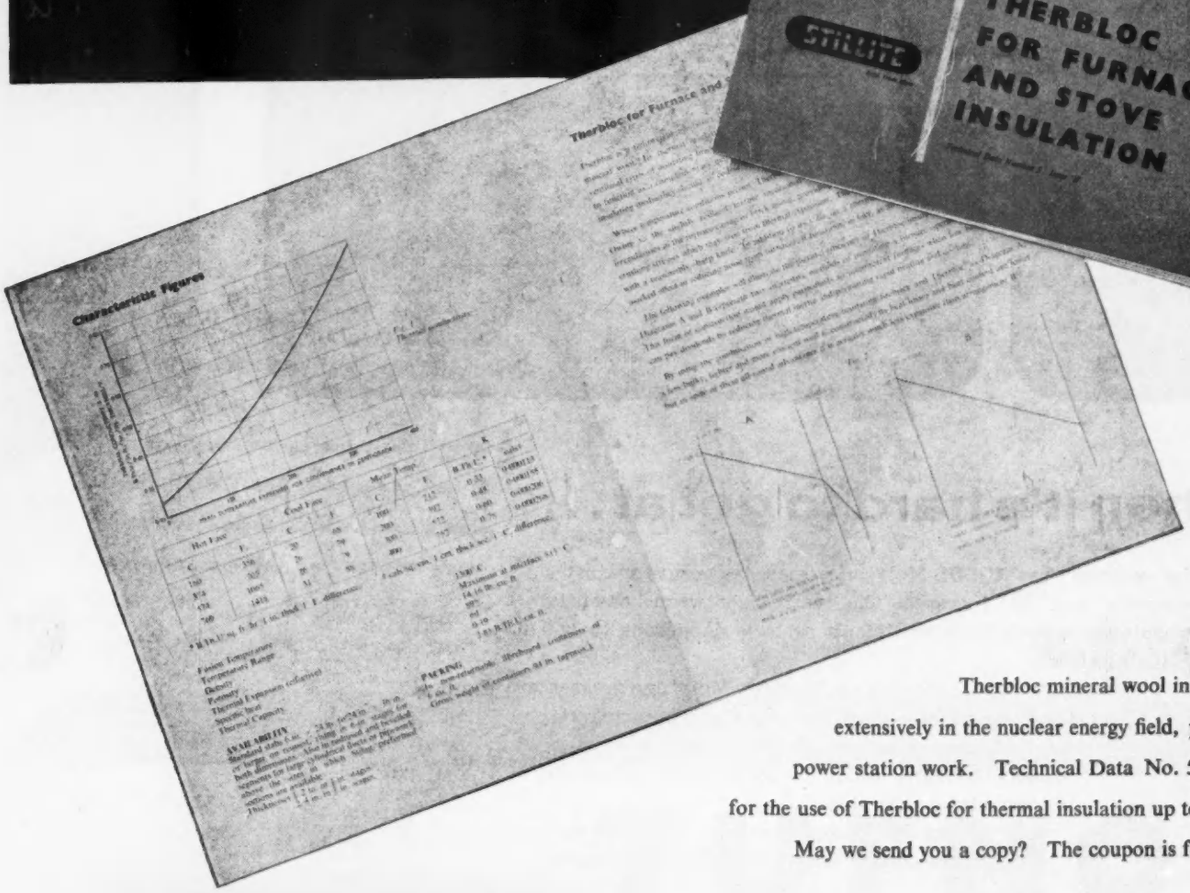

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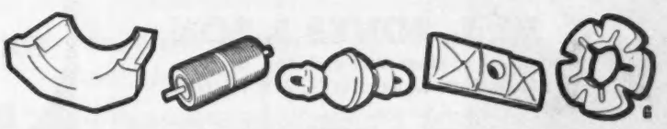

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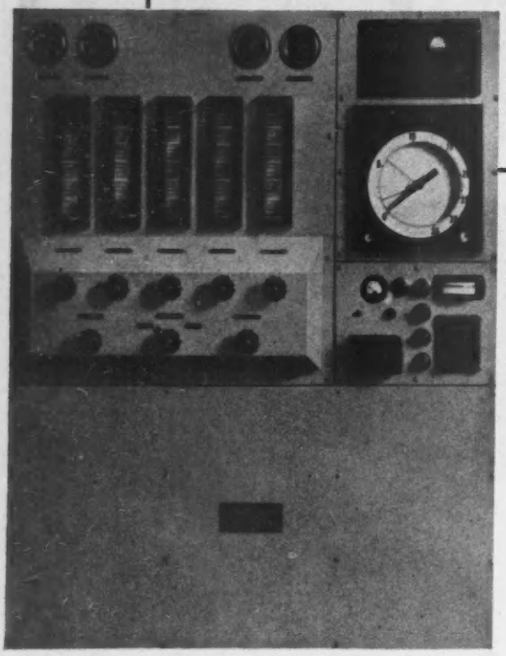

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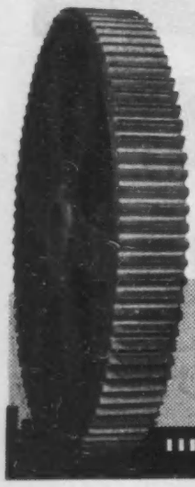

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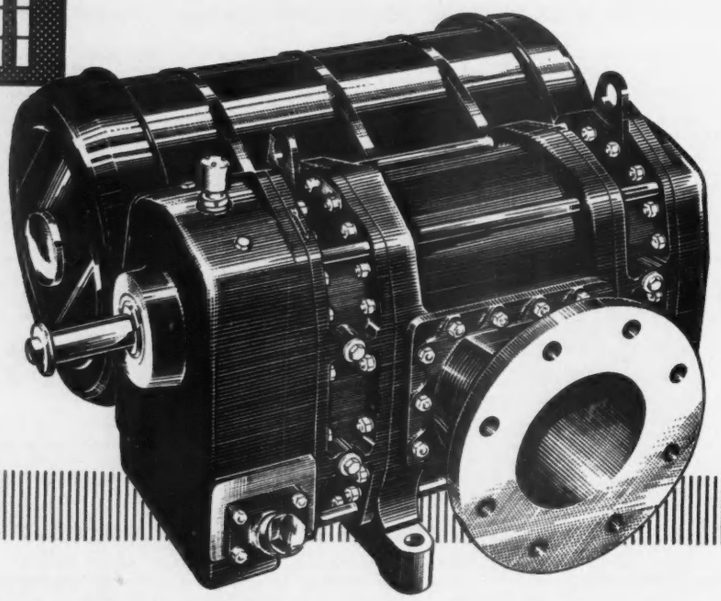

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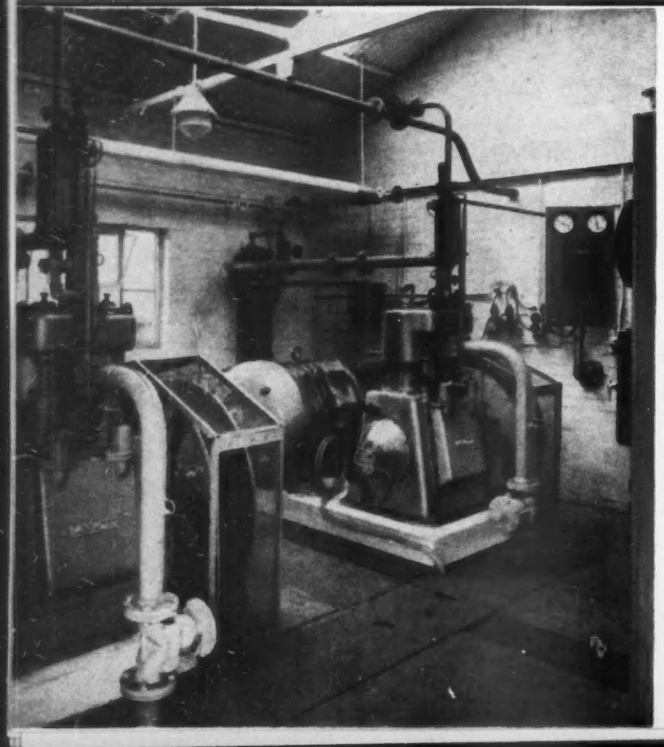

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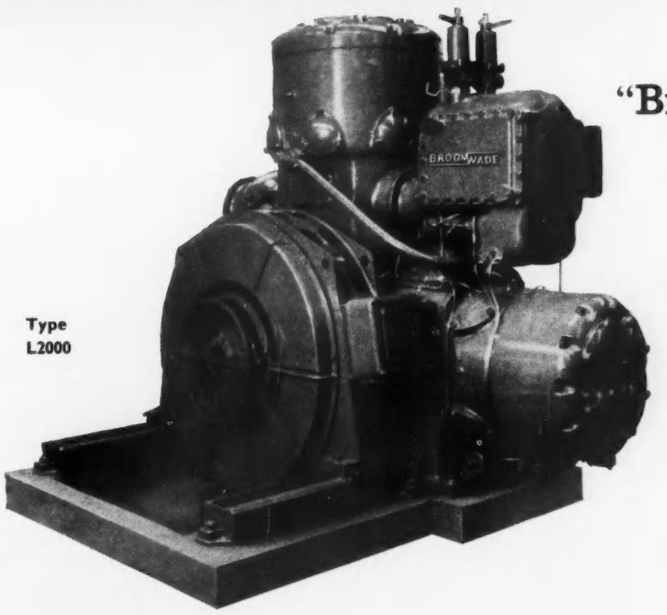

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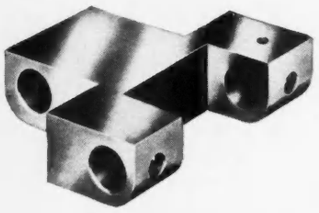

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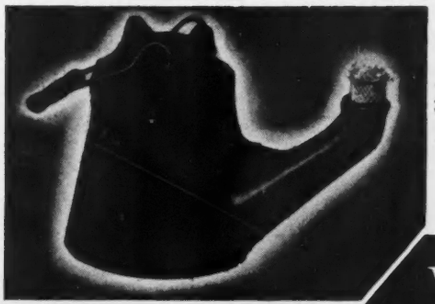

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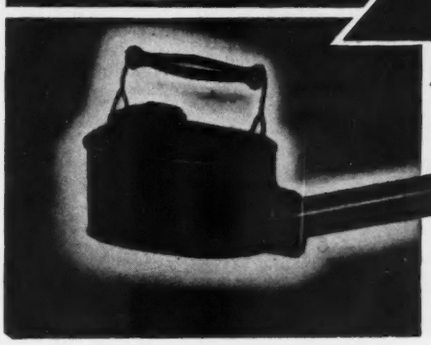

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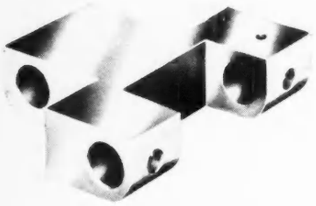

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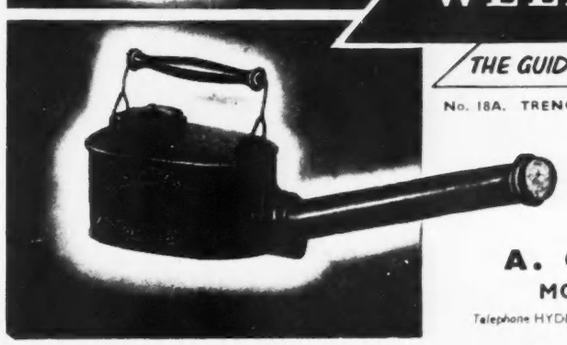

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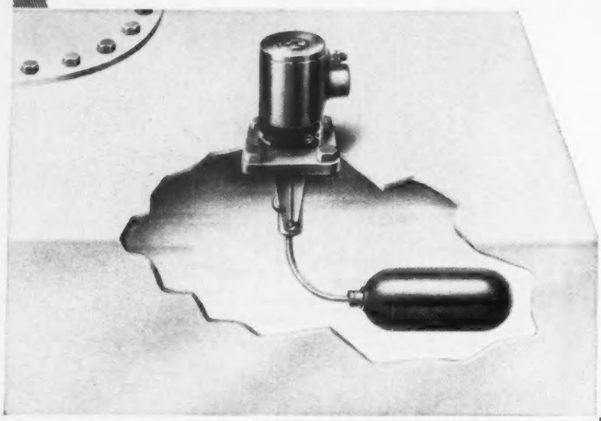

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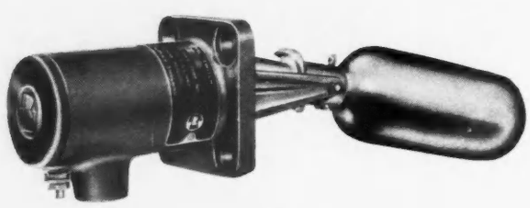

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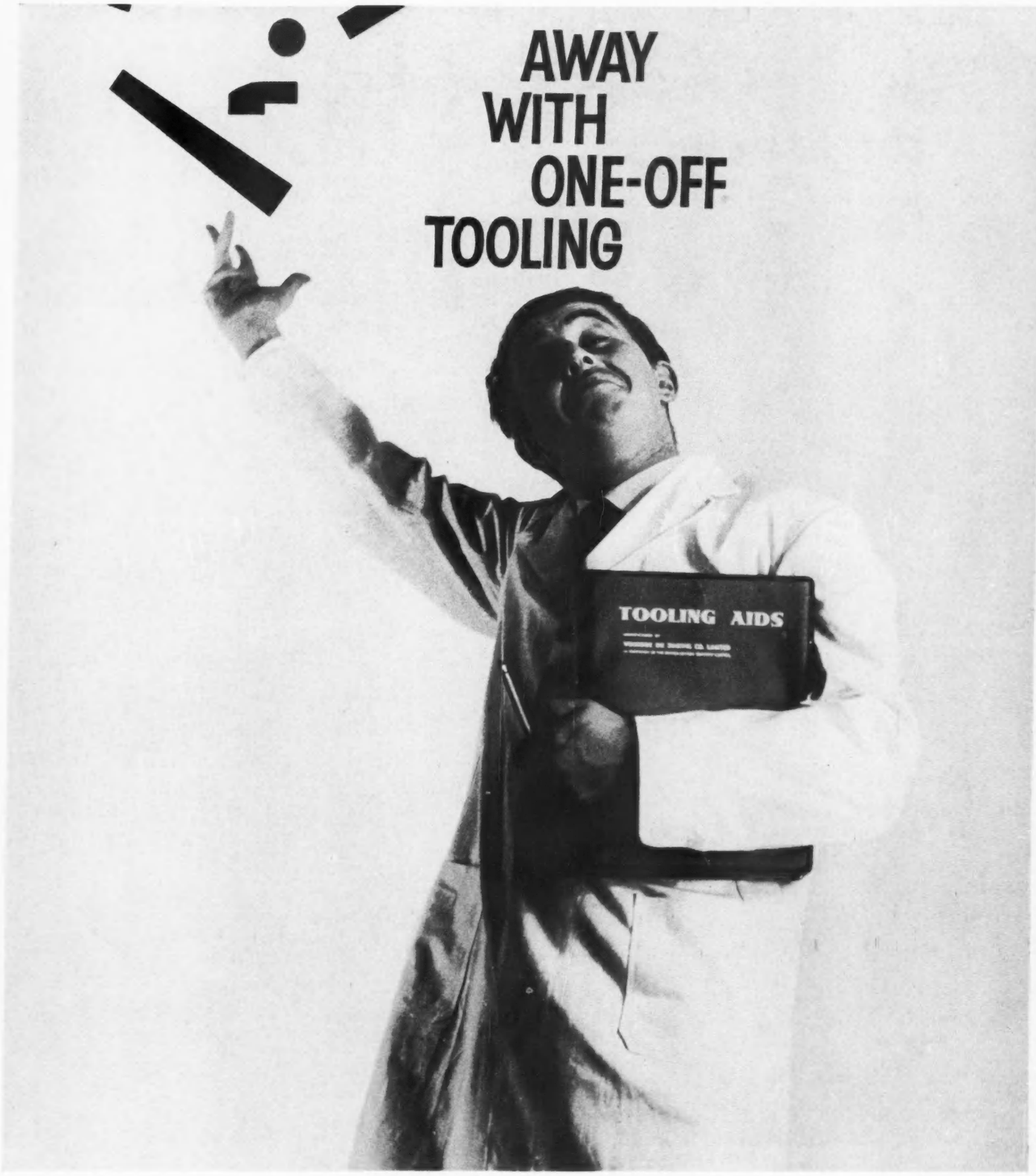

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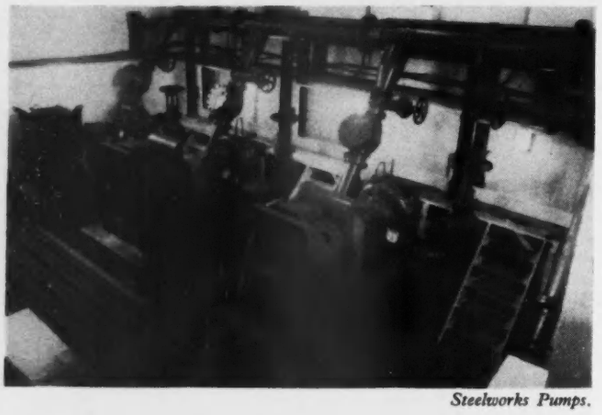

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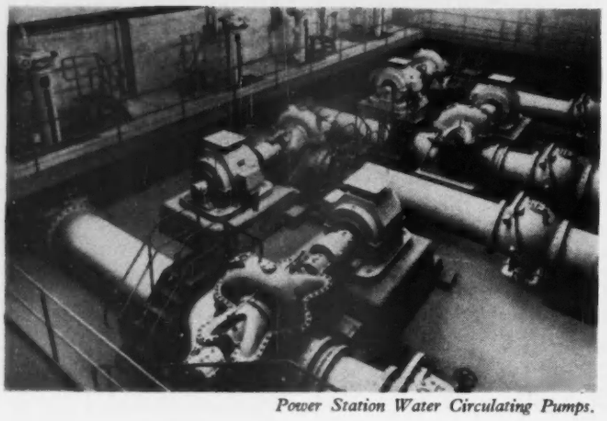

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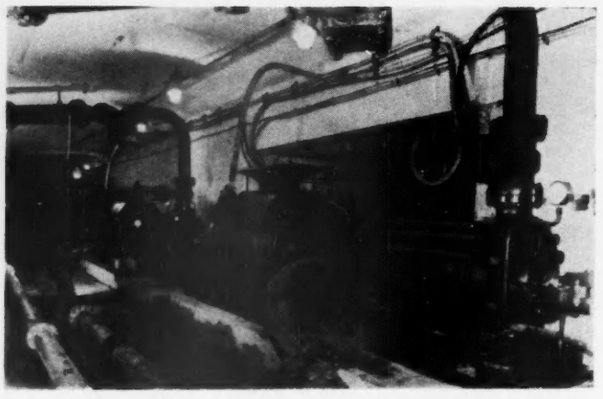

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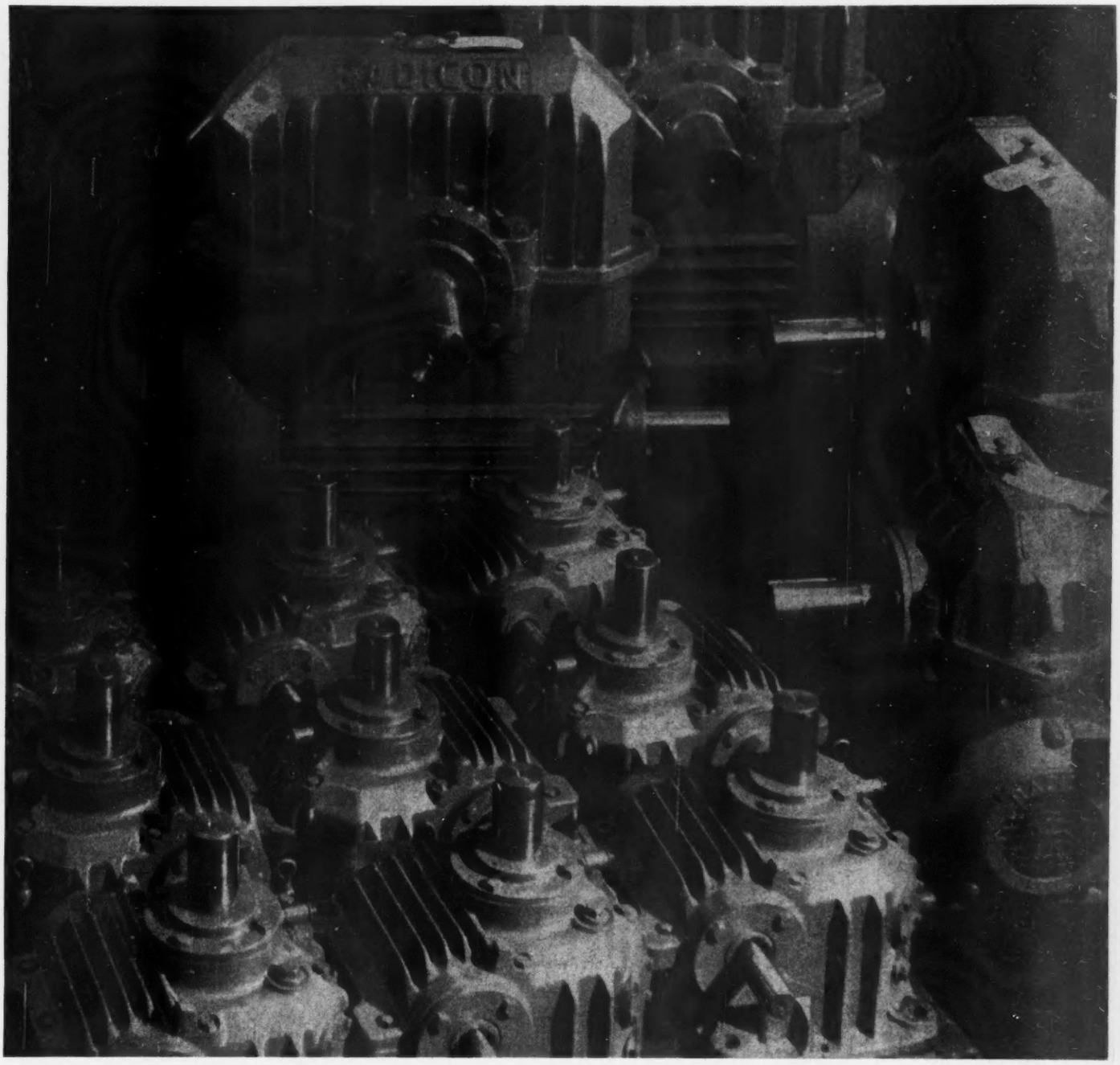

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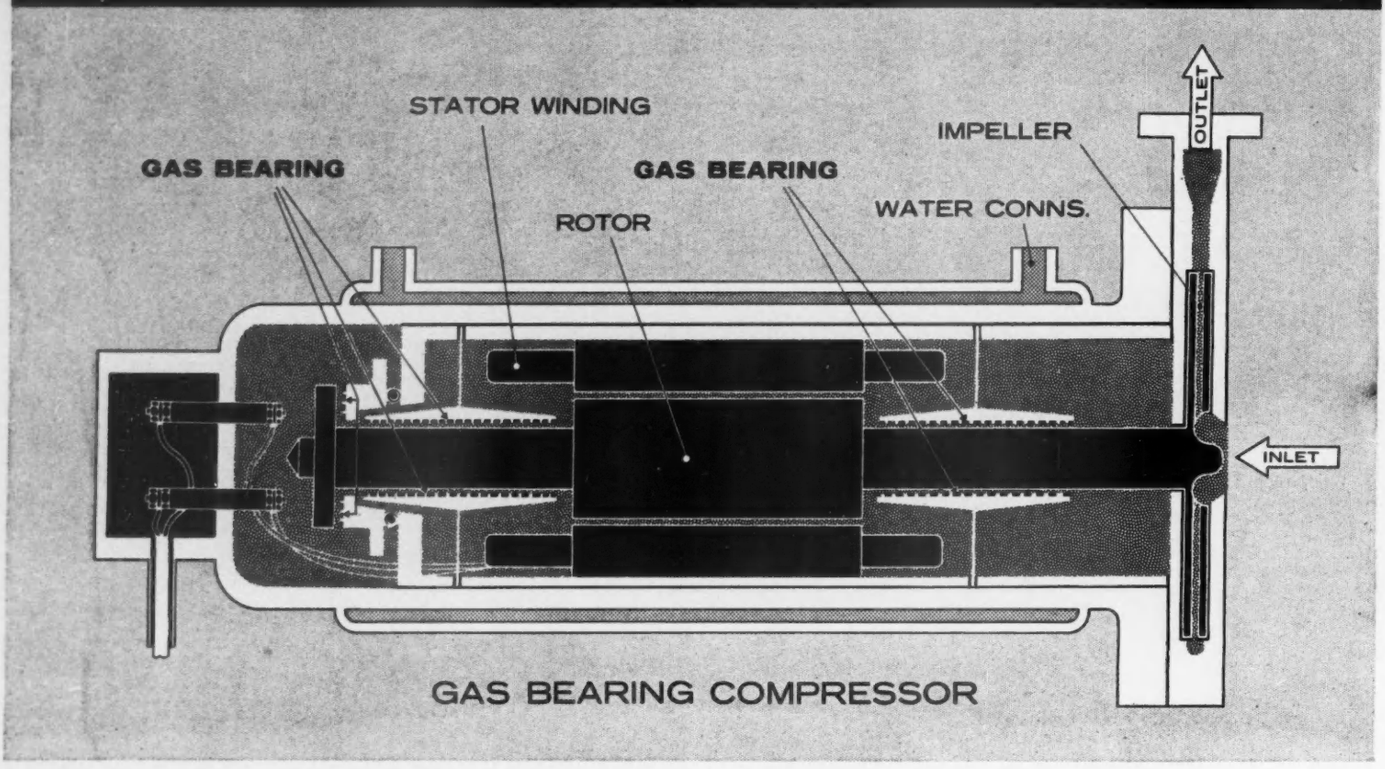

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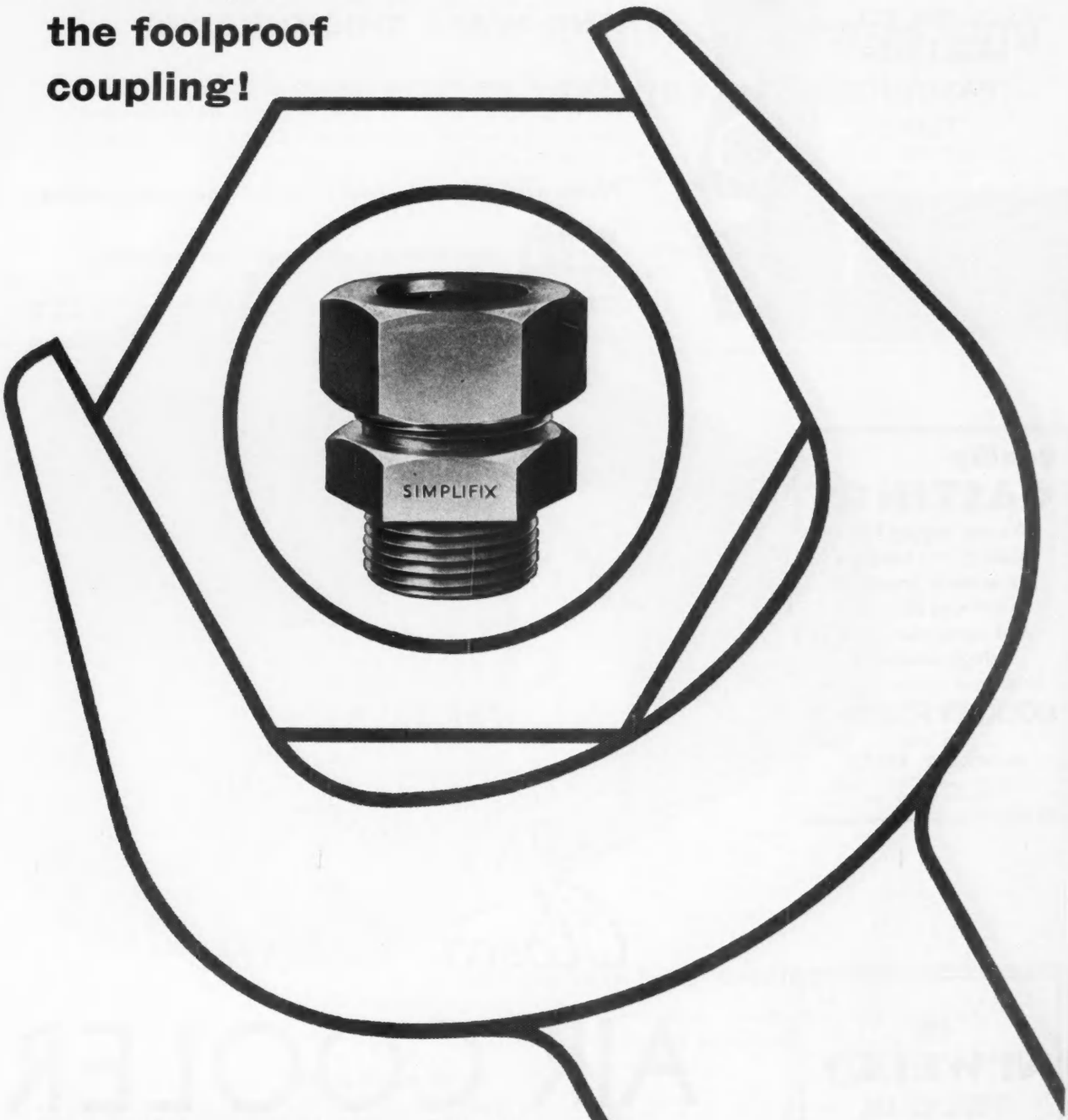

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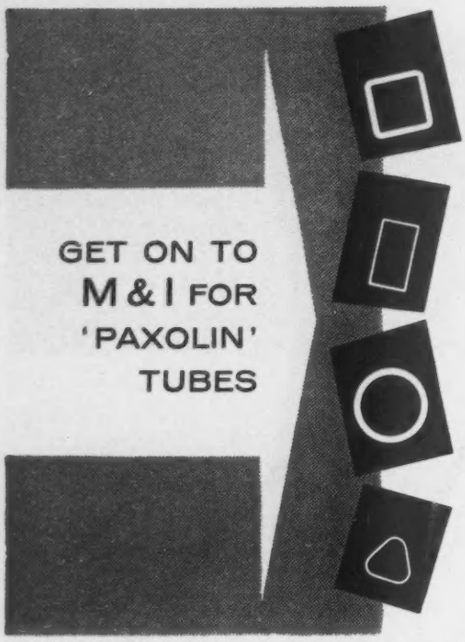

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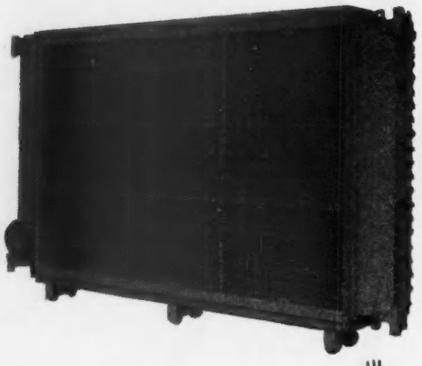

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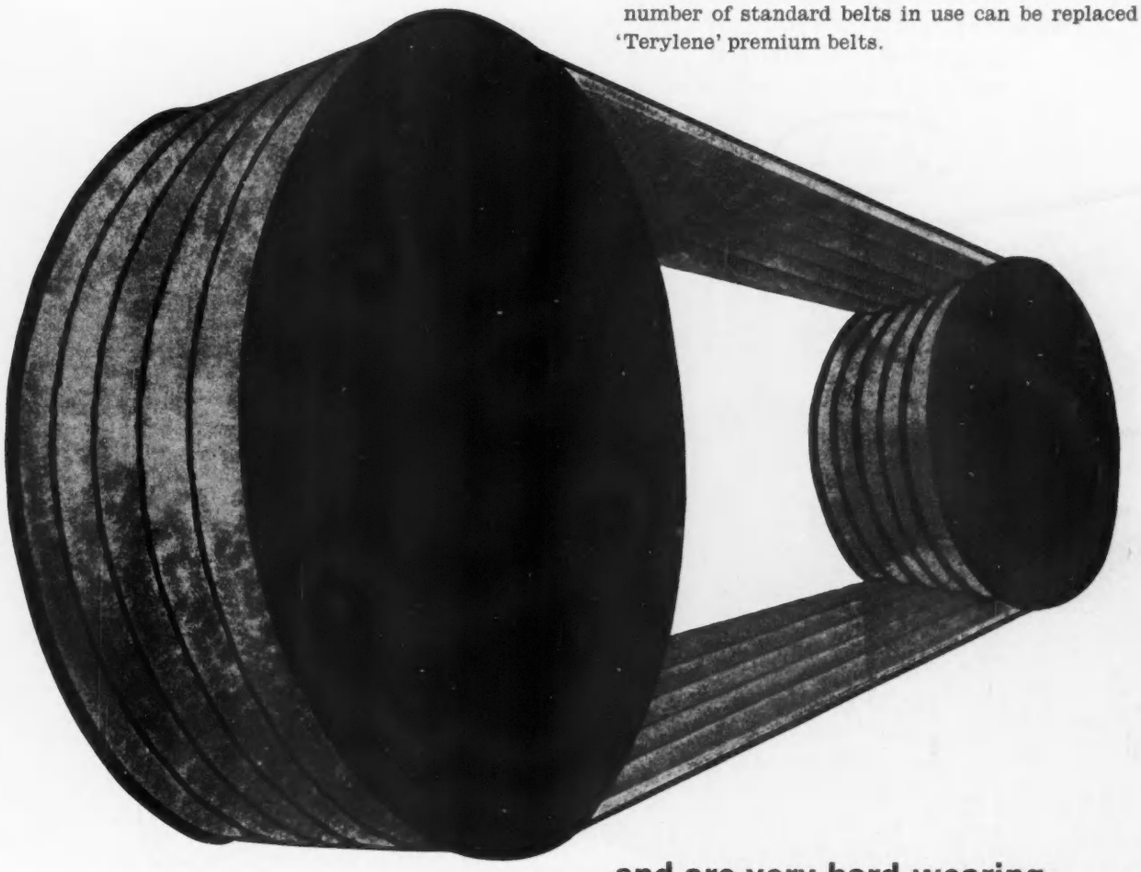

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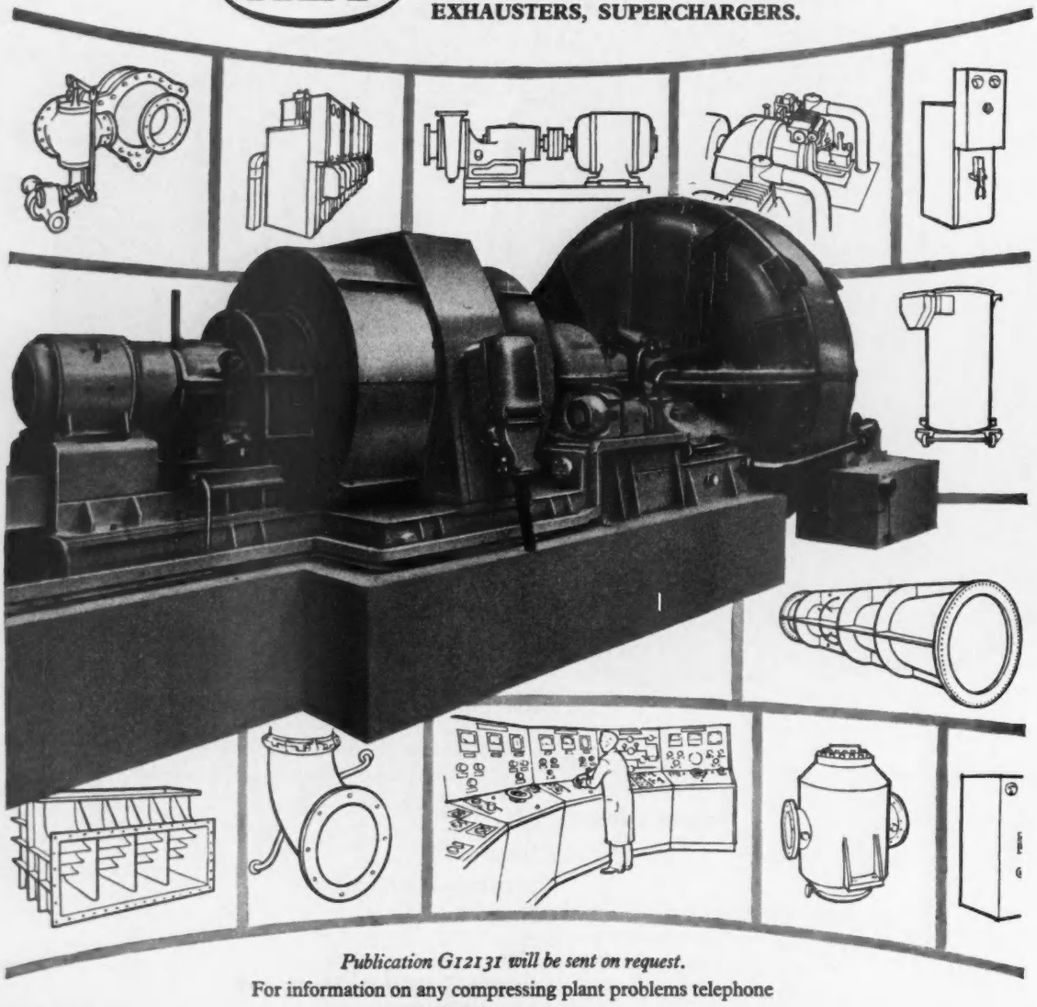

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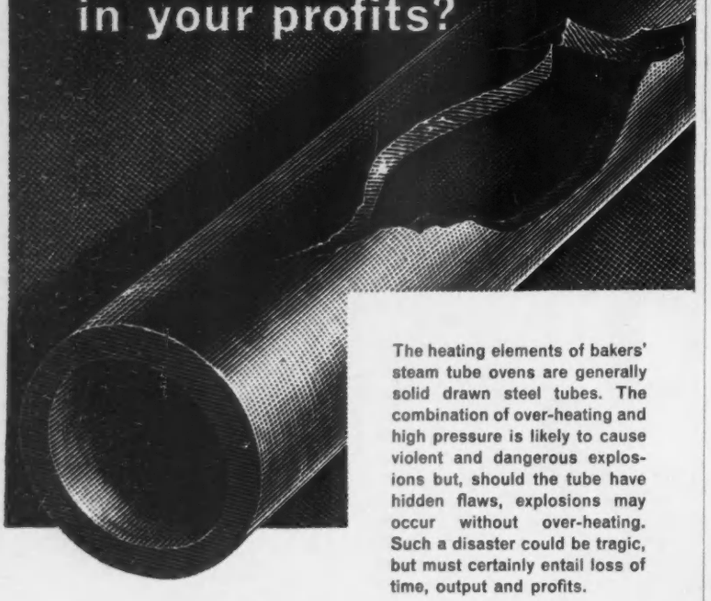

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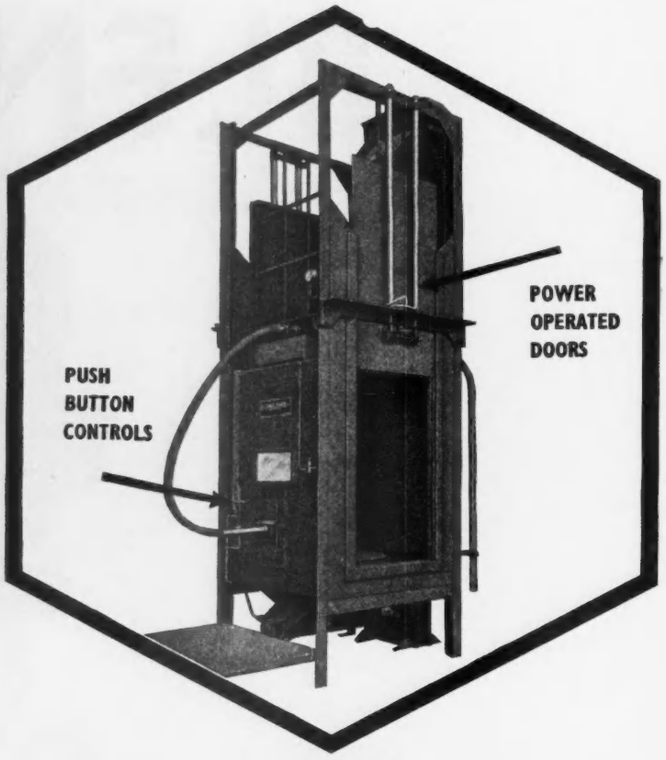

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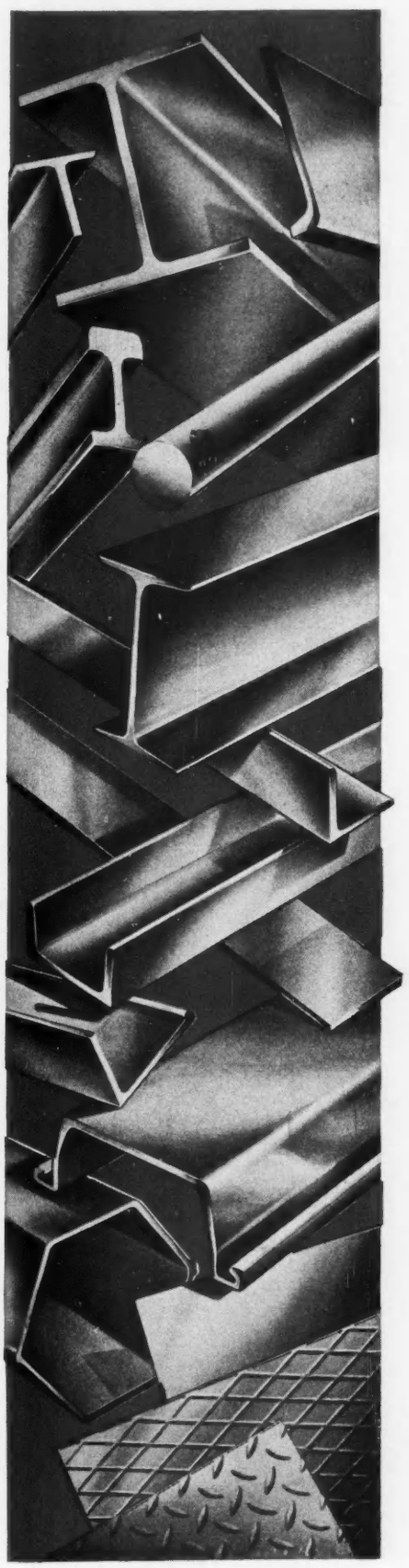

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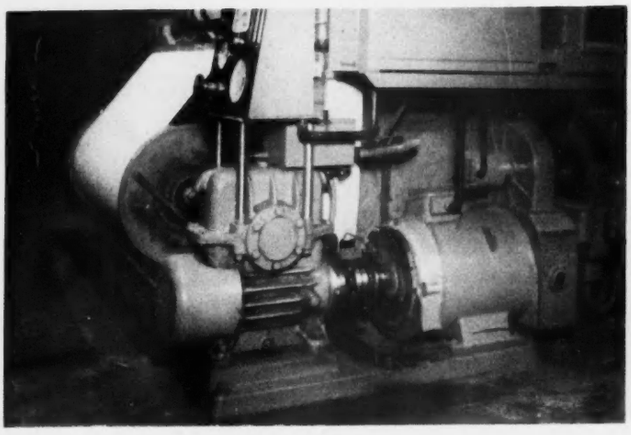

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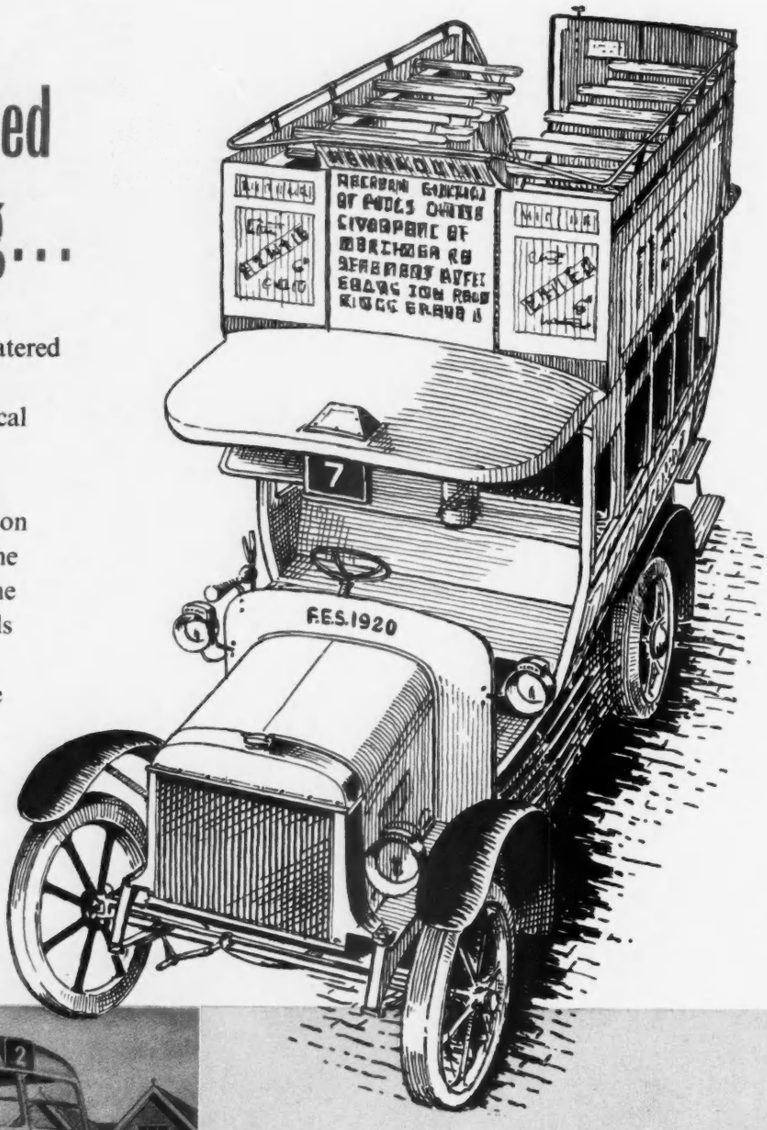

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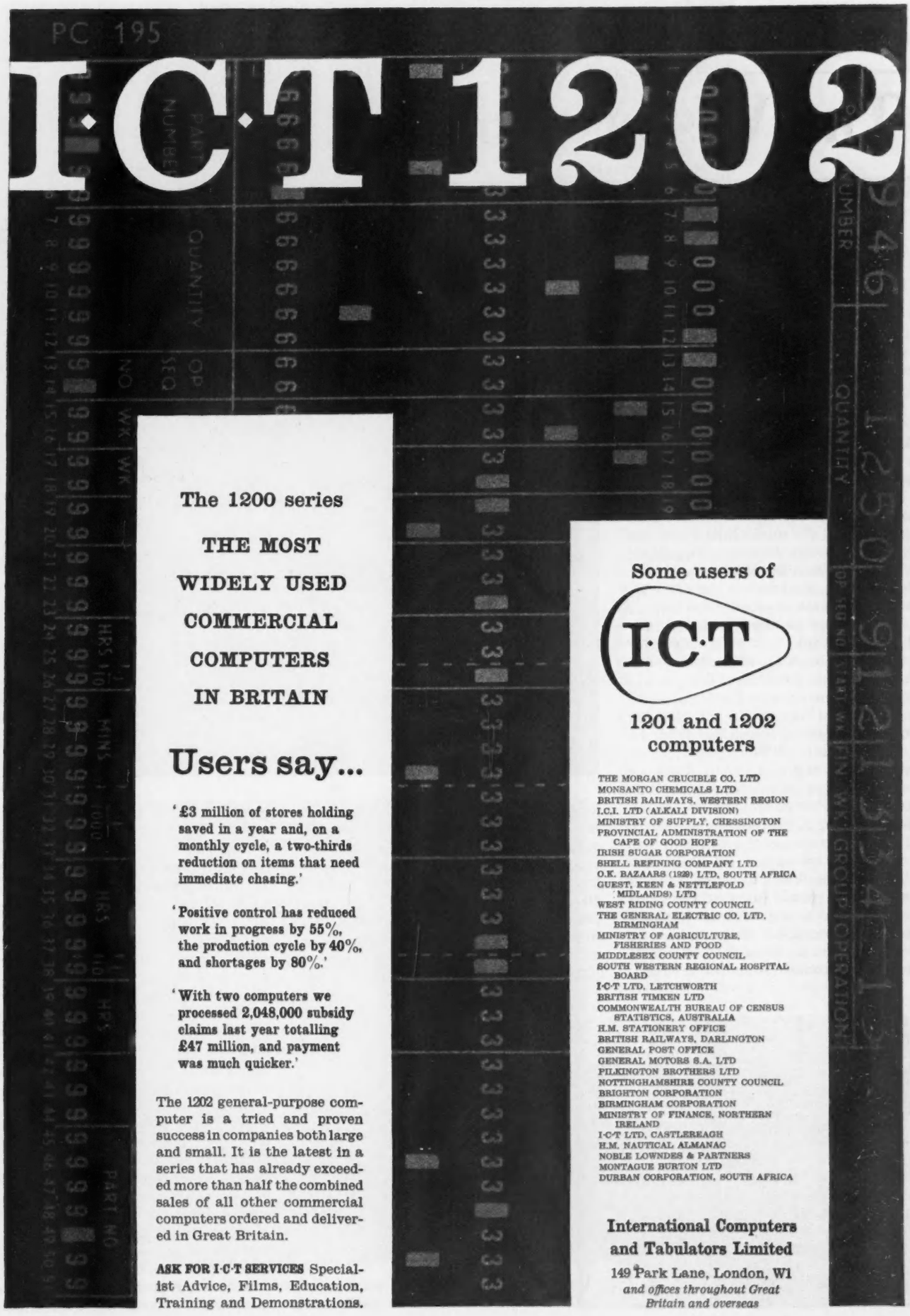

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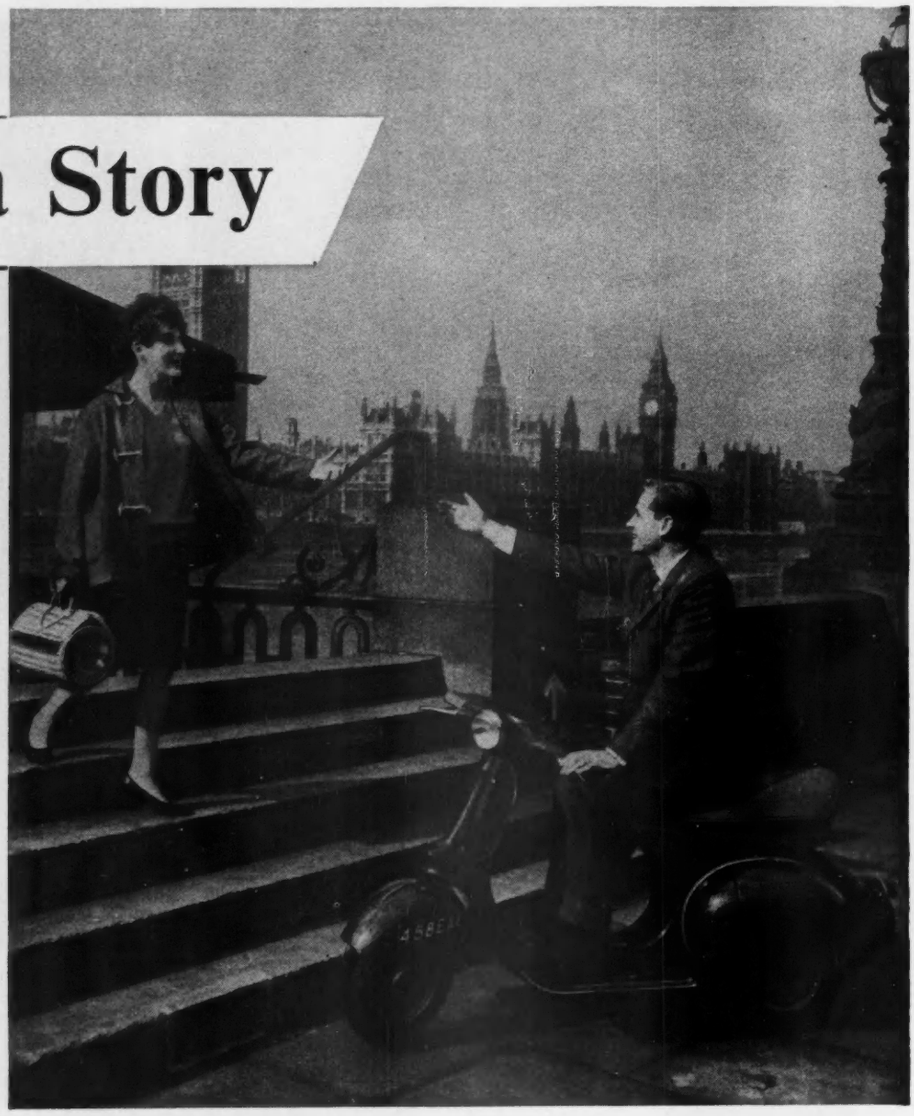

"Out of darkness cometh light"

Post-war Italy was bankrupt—physically, politically and economically it was a scene of desolation. Yet it was in this unprepossessing economic environment that Dr. Piaggio in Genoa started an enterprise which has revolutionised post-war personal travel throughout the world. Within twelve months of Mussolini's mutilation, he had produced over two thousand of the now world-famous Vespa Motor Scooters. Within ten years he was to make a million. Now, the Italian Vespa Company employs more than 4,000 workpeople and the robust little Vespa has completely democratised personal transport. Workmen in factories, doctors on their rounds, bankers, stockbrokers and film stars in every country are all proud Vespa owners. In fact, the Vespa has eradicated motor car snobbery and made tens of thousands of womenfolk motorists for the first time.

At home, pre-war, the name of Douglas was famous in the motor cycle world, but in the immediate post-war years this famous Douglas Company at Bristol had fallen on evil times. It was in the hands of the receiver when Claude McCormack, a Coventry Motor Engineer, took over what seemed an insuperable task of rehabilitation. By chance, whilst holidaying in Italy, he saw the Vespa, and although in charge of a bankrupt firm he nevertheless persuaded the then well-established Italian Vespa Company to grant manufacturing rights to Douglas. The Vespa brought success to the bankrupt Douglas organisation; the jobs of more than a thousand people were saved; bank overdrafts were repaid; shareholders realised unhoped-for prices for shares worth previously only a few coppers, and the Douglas Company became worthy of purchase by the powerful Westinghouse Brake and Signal Company Ltd. Thus the birth of the British Vespa took place also in an environment of economic desolation. Now the Douglas Company at Bristol employs nearly 2,000 people and the output of the Douglas Vespas has topped the 100,000 mark. Quite recently the 'Financial Times' reported that the domination of the United Kingdom scooter market by imported models looks like ending. United Kingdom production has increased 100% in the past twelve months and imports only a quarter, whilst British exports to the United States, the Commonwealth and Scandinavia are expanding. If any proof is required that trials and tribulations inspire mankind to prodigious effort, surely the Vespa story is a pertinent example.

At Kingswood there is a modern Vespa production line modelled on the motor car industry. Large presses stamp out the framework and overhead conveyors take the chassis and components to the paint and assembly shops.

However, the Vespa's attractive colour coat serves as a protective mantle to the robust and reliable power, transmission and braking systems which lie beneath. The construction of the components for these systems presents many problems for the metallurgist. Most of them depend upon heat treatment, carburising, tempering, etc., which demand very close time/temperature schedules. For this reason most of the furnaces are on automatic temperature control where thermocouples

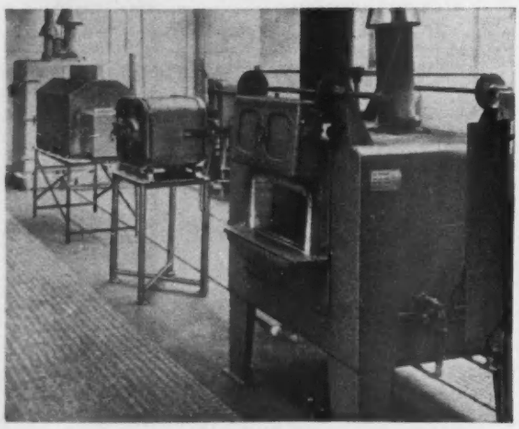

Fig. 2. A view of the new industrial gas showroom opened by the South Western Gas Board.

measure the temperature and transmit an electrical signal to control pyrometers which operate valves in the gas supply according to the measured temperatures. This ensures that the temperature never varies from the close limits necessary for correct heat treatment which largely determines the life of the components. The Douglas Company uses town gas supplied by the South Western Gas Board for melting, hardening, tempering and carburising as well as stoving the synthetic paint finishes. For these purposes town gas is the most suitable fuel because its declared calorific value lends it well to precise automatic control. Other advantages are, of course, that there are no interruptions for fuel deliveries, and the gas meter provides the simplest and cheapest form of fluid fuel costing.

In the foundry gas is used for core drying, and aluminium alloy melting is carried out in three gas-fired melting furnaces, the molten metal being used for the gravity die-casting of the light alloy components. Crankshafts, gears, etc. require special heat treatment to fit them for their arduous life, and in the Carburising Shop there are three gas-fired muffle furnaces as well as a high-speed tempering furnace. Other non-ferrous components are treated in gas-fired salt bath furnaces.

The standard of finish on the Douglas Vespa is extremely high. The chassis, mudguards, etc. having been assembled, stress-relieved and filled, pass on conveyors into the finishing shop. After being sprayed with a number of priming and finishing coats of paint the components pass, still on conveyors, into a gas-fired infra-red paint stoving oven which was specially designed to suit the awkward shape of the chassis, thereby ensuring that each part of the painted surface received adequate heat. Again town gas was chosen as the fuel because it lends itself more easily to the close time/temperature schedules required to cure the modern synthetic paints. Undoubtedly the large output of Vespa Scooters has benefited from the close co-operation between the South Western Gas Board, the equipment suppliers and the Douglas Company. As part of its service to industrialists in the South West the South Western Gas Board has recently opened an Industrial Gas Showroom where factory executives can inspect working examples of infra-red tunnels, natural draught oven furnaces, muffle furnaces, recirculating ovens, etc. Anyone can bring along the components in which they are interested and try them out with the equipment in advance of purchase. A small pottery kiln is in great demand by schools in the district, and examples of decorated and glazed pottery reflect high credit not only upon the schoolboys and girls but upon the precise time/temperature schedules obtainable with town gas in a relatively inexpensive kiln. In addition, there is a wide range of gas burners together with ancillary equipment such as flame protection and ignition systems where automatic temperature control figures prominently.

This Industrial Gas Showroom is one positive example whereby the Gas Industry through its Industrial Gas Officers at the Area Gas Boards is serving industry—these officers from all over the United Kingdom meet regularly to discuss developments, so that any manufacturer approaching any Area Gas Board has at his disposal the pooled knowledge throughout the country in some 4,000 different trades and industries served by gas. One practical result of this service is reflected in the Douglas plant at Kingswood, Bristol—and the name of Douglas is in turn reflected in the ever-increasing market for its ever popular and glamorous Vespa Scooter.

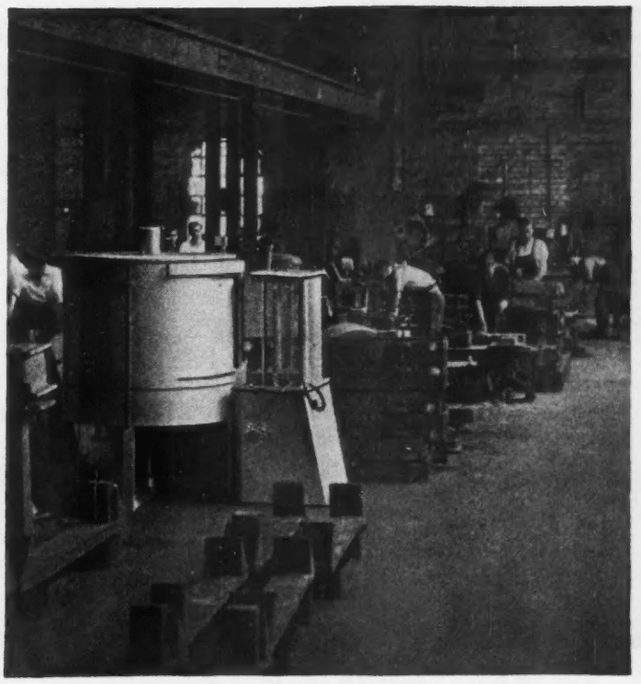

Fig. 4. A view of the gas-heated core drying installation in the foundry of Douglas Engineering (Kingswood) Ltd.

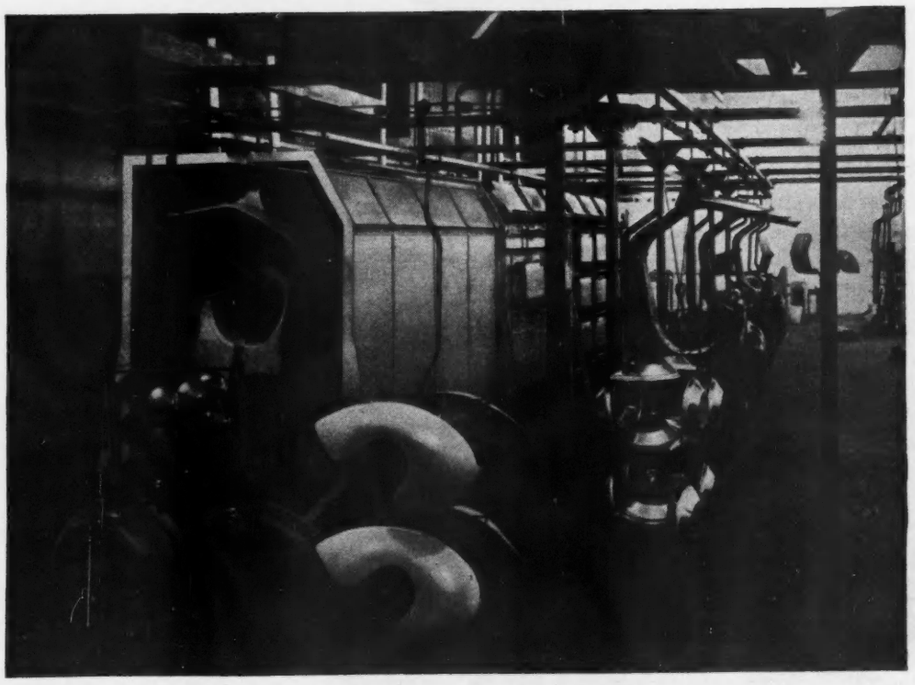

Fig. 3. Gas-fired paint stoving oven for Vespa parts including chassis, lamp housings, steering columns with mudguards, engine wings and fan cowlings, installed at Douglas Engineering (Kingswood) Ltd.

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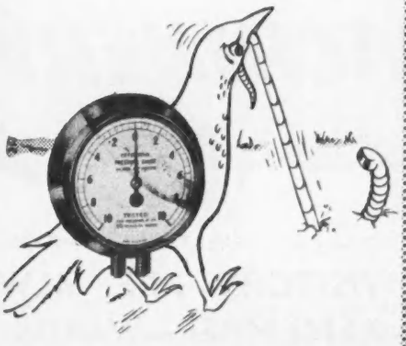

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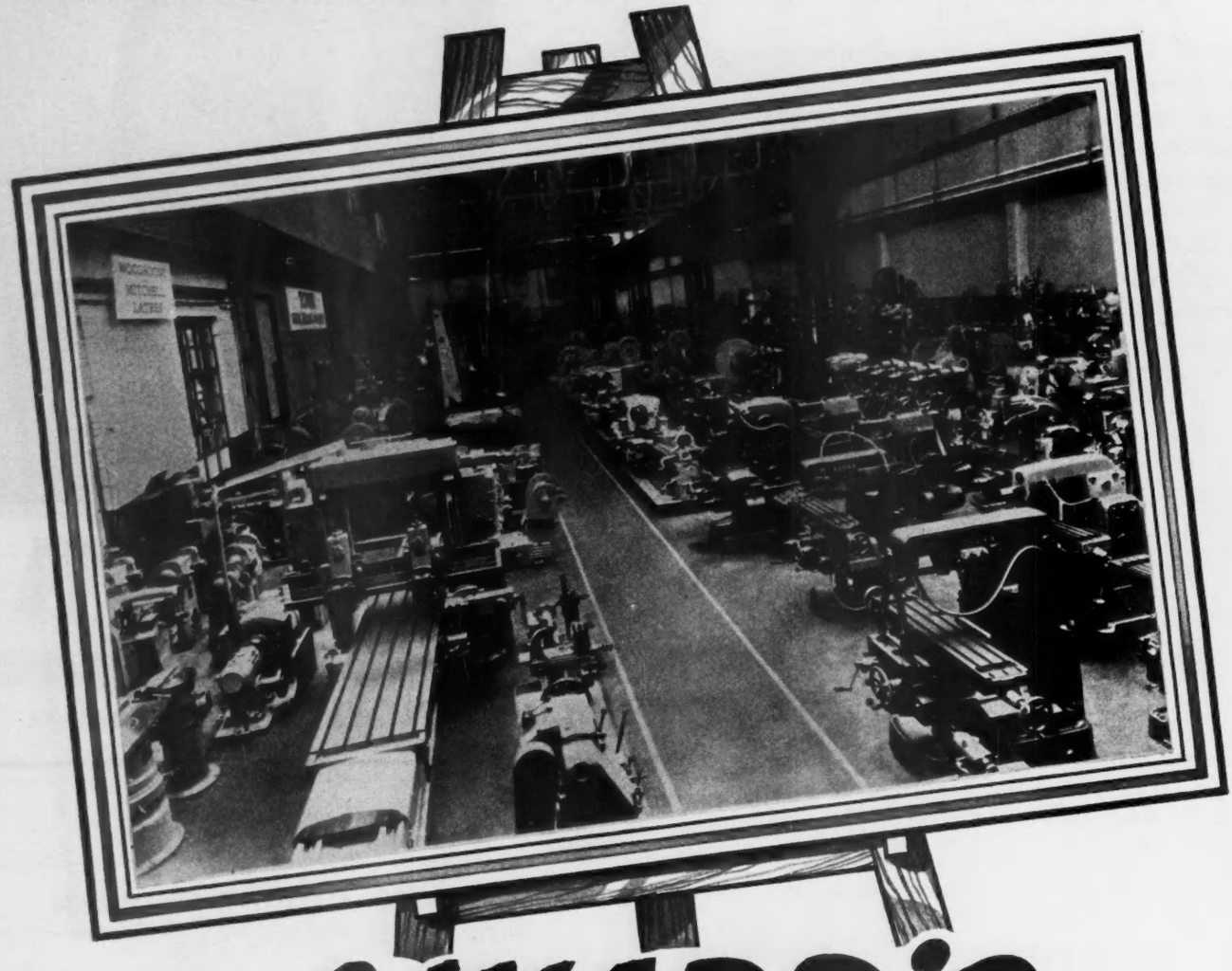

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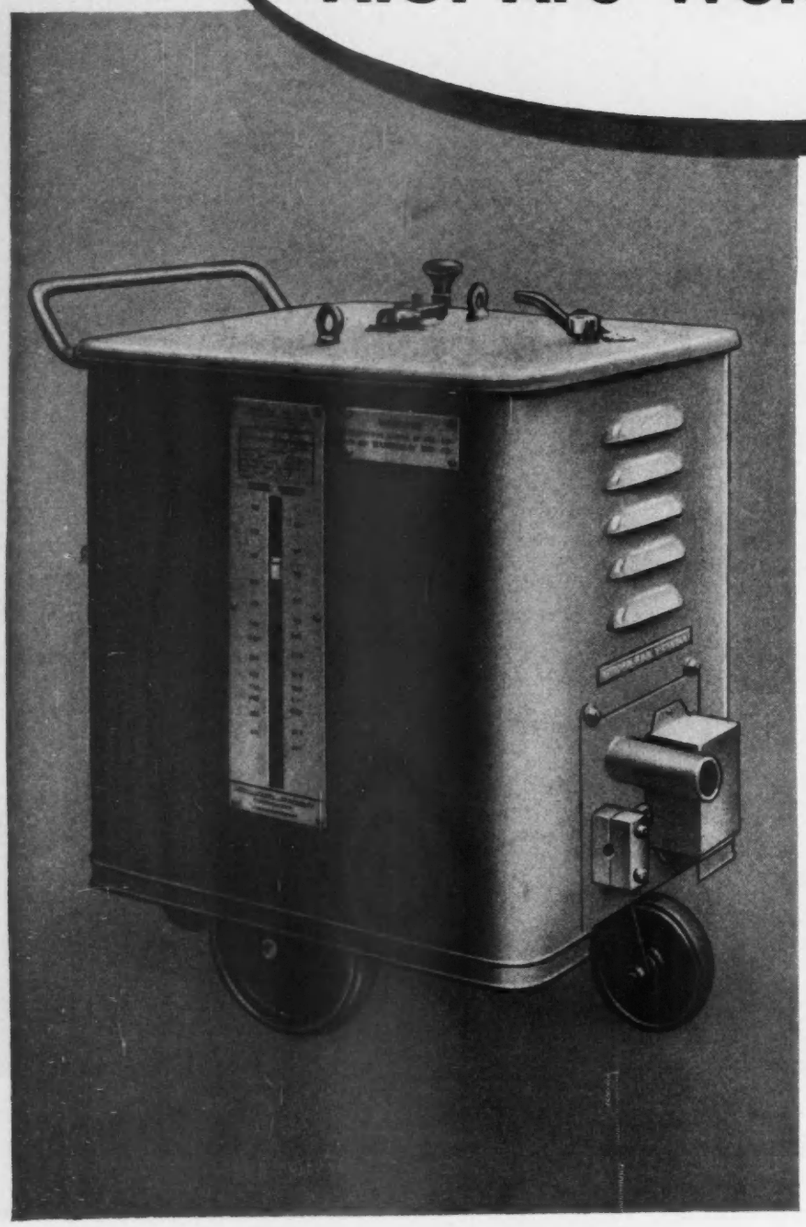

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Excellent news on the state of the nation's industry has accompanied the first weeks of the year. An £85 million fall in the gold and convertible currency reserves in December came about for the worthy reason that £66 million was paid in interest and repayment on the United States and Canadian loans. At home the hire purchase debt rose by £24 million in November, the rate of borrowing for cars and household goods quickening slightly over the month before.

From the shipyards came the news that December brought almost as much tonnage ordered, all but 100,000 tons, as in the first three quarters of the year (146,000 tons) and in the first three quarters there had been cancellations of 141,000 tons.

Of United Kingdom industrial activity generally, the Treasury revealed that November brought the level of production to a point 10 per cent above that of the year's beginning. The Ministry of Labour produced figures that slightly more people were in work. What does all this mean for the engineering industries?

First that the general air of confidence is carrying the improved conditions in the firms supplying direct to the consumer far beyond those companies. Not only cars and washing machines, but steel, textiles, general engineering, and machine tools are contributing to the increased output.

One major steel concern, United Steel Companies, in its latest figures, shows that its ingot steel production increased by 200,000 tons in 1959 to 2,802,452 tons. USC pig iron production reached the record 1,822,127 tons (153,842 tons more than in 1958) although one of the four Appleby-Frodingham blast furnaces was not in use for most of the year. Coke and iron ore production records were also broken during the year.

95 per cent

The steel industry in general was using its mills at 95 per cent capacity towards the end of the year, a rate which indicates demand from general engineering, including the heavy section. Chemicals, oil, and plastics are all running at increased production or delivery rates and even coal production in the first week of the year was running behind demand. The week's output was 3,022,900 tons and the consumption of the week before (Ministry of Power statistics are not made for easy reading) was 3,959,000 tons. At the close of the year coal stocks were still above 50 million tons but were 848,000 tons less than the week before. The National Coal Board's greater sales and service efforts and the increasing industrial tempo may go on making inroads into the costly coal stocks.

It is not so certain that the brighter news from the shipyards will continue. The three useful orders placed in December, all by Norwegian operators, were in size only a shadow of former orders. Worth more than £10 million they add at least twelve months work to the order books of Joseph L. Thompson, of Sunderland, and Lithgows, of Port Glasgow. Some of the shipping orders, when they are brought home against dire competition from Sweden, Germany and Japan, have had a great part of the profit removed in the struggle.

United (Trading) States of Europe

The presence in Paris this week of Mr. Dillon, the United States Under-Secretary in charge of economic affairs, is evidence, if more were needed, of the keen American anxiety that there should be agreement and not a rift between Europe's two trading groups, the Seven, including Britain, and the Six, including West Germany.

One week's discussion, after the years of argument that have achieved the present, is not likely to solve the differences but apparently there is a hope in the State Department, from which Mr. Dillon comes, that some form of consultative machine will be agreed from which working agreement would evolve.

The Americans are not alone in seeking a wider economic community than the Six, the Seven or even the Organisation for European Economic Cooperation. From the idea of an Atlantic area they have gone on to a position where the suggestion is now being put about in Congress that OEEC should link up its existing members with industrialised Canada and USA plus India and a Latin American representative, perhaps Brazil. This would give a global aspect to a body which has tended to lose its significance as the European Economic Community (the Six) and to a lesser extent the Seven, have made the running in setting the conditions for Europe's trade. In such a grouping the fact that there are within the Six and the Seven two groups of states each of which has more in common with its opposite number than the rest of its trade area would make itself felt. Both in Britain's European Free Trade Area and in the European Economic Community there are countries that are heavily industrialised and those that are not.

If, in the '60s, the western states increasingly get down to the job of helping the less developed nations, then the parallel interests of the industrialised groups may well draw them more and more closely together.

Affluence

In this connection it is worth recalling that political activity is not separable from industrial affairs. Speaking at last week-end's international congress at the Hague, the British MP Mr. Anthony Crossland, who wants the Labour Party to be known by another name, spoke of a coming period of "mass affluence."

As Mr. Crossland observed, this does not mean there are no issues left for the political struggle. It could mean that the resources available for debate will be spent on arguing for the have-nots overseas, perhaps with benefit for the Asiatic, the Indian and world trade.

of Patent Practice in Russia

The British delegation which visited the Soviet Union to discuss patent protection returned with the opinion that those who took out patents in the USSR would have only their fees to lose and might have a good deal to gain.

Considering the assurances the delegation received from the Committee on Inventions and Discoveries they thought it only reasonable that the Russian system should be given a try. The Russian patent system, which was revised in April 1959, is essentially similar to patent laws in the West. In practice, the Russian or foreign inventor has, under Soviet law, the choice between applying for a patent, or an author's certificate.

A patent gives him monopoly rights in his invention. The author's certificate assigns his invention to the state, which pays him in relation to the use made of the invention and to the benefits derived from its use. The certificate involves very much less expense for the inventor and obviously is very much more suited to a socialist economy. The result is that Soviet engineers and scientists with ideas and inventions customarily seek author's certificates. Foreign inventors apparently stick to the customs with which they are familiar and try for patents.

Under Soviet law, when there is no contractual obligation, inventions can be copied unless they are patented in Russia. But if the necessary steps have been taken they can be and are protected. A patent is not granted until the invention has been described in a specification and a search is then made through technical literature and foreign and Soviet patents to make sure that what is being patented is new. There must also be actual or potential "industrial utility." This will be the subject of the opinion of the appropriate Soviet technical organisation.

15 years

Once these conditions are fulfilled, the patent is granted and runs for 15 years, renewal fees being paid each year. As in many other countries, the Government reserves the right to issue compulsory licences "where an invention is of special importance to the state" and if this were invoked would remunerate the patent holder. The Russian system provides that the patent holder has the right not only to stop others from making things that incorporate his invention but also from importing them.

What the industrialist considering a link with the Soviet Union will also want to know is what happens about disputes. The answer that the delegation brought back was that disputes as to the ownership of patents are heard by the ordinary courts and that infringement actions can be brought before them also. How such cases would fare is another matter, since it seems that no such actions have ever been brought.

The delegation, which was led by Mr. Gordon Grant, the Comptroller General of Patents, found their Soviet counterparts anxious to avoid any misunderstandings and evidently close students of the International Convention. While they seemed to be tending towards bringing their practice into accord with that of other states they gave no indication that Russia might be likely to join the Convention.

The Steel Industry's Confidence

When money and prosperity abound, technical developments flourish. They are likely to flourish more, now that the steel industry is informing the nation of its resolute plans for future expansion.

An industry as basic as steel might be thought to tag along according to the ups and downs of its customers, since it would clearly be foolhardy to produce substantially more or less than the customers require. In fact, the steel industry is increasingly taking on the role of the first violin, if not the conductor. Because the time required for expansion of plant is much longer for the industry than for most of its customers, the British Iron and Steel Federation have to assess the likely demand for years hence. They do this by studying each using industry and preparing a total estimate. In basing their plans for expansion on this estimate, the Federation are giving a lead to the whole country. Other long-term industries, like shipbuilding and machine tools, may find the steel industry's confidence is infectious.

Figures worked out by the Federation show that the engineering and allied industries have increased their production by 82 per cent since 1946, compared with only 60 per cent for all UK industries. Everything points to the continued dominance of the engineering industries.

and the Christmas Aftermath

The deadly reckoning on the roads over Christmas unfailingly produces figures that are shocking to read.

This year they were worse than ever, 66 people dying on the roads on Christmas Eve (30 more than in 1958) and 147 being killed in the four days of the holiday (61 more than last year).

Away in the United States Mr. Marples, Minister of Transport, called this "appalling" and referred to the need for segregating vehicles from pedestrians. Be that as it may it is also worth recalling the story of the man from a Western nation who carefully explained to a non-Christian—"Tomorrow is the anniversary of the Saviour's birthday. Take care on the roads, all the drivers will be a little drunk tonight."

Presumably there is a fair chance that next Christmas will be even worse in road deaths and injuries than this; there will certainly be many more cars about. The Press tried before the holiday to remind people. Articles quite removed from motoring ended up with little requests to avoid mixing drinking with driving. The BBC kept up the reminders—but the combined number of dead and injured rose by 544 to 4,651.

Exhortation is notoriously weak in the face of human frailty or over confidence. Perhaps at some not too distant date the weather men will be able to induce a howling blizzard to blanket out the casual roisterer and reduce the number who begin the New Year as orphans or as bereaved parents.

Making New Metals Ductile and Massive

It has required the entry of vast government expenditure on space research and nuclear power to acclimatise material producers and users to the idea that there is a future for metals which cost £55 a pound instead of £55 a ton as for steel. Such metals quickly acquired the titles " new " and " exotic " and have commonly been thrown together into a family.

What perhaps is less realised is that there exist more genuine family ties, in that nearly all the new metals are difficult to fabricate into massive form, and tend to be brittle if impure. This collection of notes is intended to illustrate what is being done by the organisations with the resources on these metals, and to highlight some of the common problems.

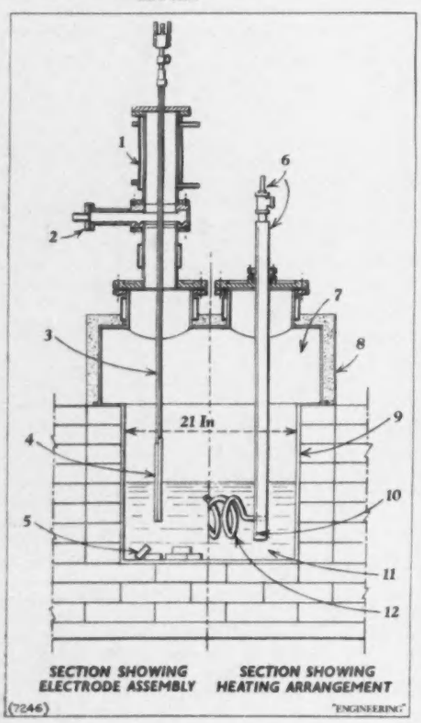
Titanium Mastered

Making large ingots of ductile titanium and its alloys is not easy. The metal is very sensitive to gaseous impurities such as oxygen and nitrogen which increase the strength and reduce ductility to zero. It is therefore impossible to melt it in air, and because of its high reactivity when molten, normal refractory containers cannot be used. The most recent furnaces installed by ICI Metals Division in this country are of German design and produce ingots up to 4,200 lb in weight by melting under vacuum. The ingot starts off as a consumable electrode made up of briquetted granules which are welded into one electrode of 12 ft in length weighing about a ton. Alloying elements, in amounts which allow for losses in melting under vacuum, are incorporated in the powder before briquetting.

This consumable electrode arc process of melting is carried out twice in order to get rid of gases to the required level. The second time the electrode is the still-hot ingot from the first melting stage only melted into a crucible of larger diameter.

Fig. 2 Construction of cell for recovery of impure titanium.

1. Water-cooled receiver
2. Slide valve
3. Water-cooled copper cathode bar
4. ½ in titanium rod cathode
5. Titanium scrap (anode)
6. Water-cooled electrode, mild steel
7. Atmosphere of helium after evacuation
8. Vermiculite insulation
9. ½ in mild steel
10. Heating electrode
11. Melt starting coil, mild steel



Induction Melting:—Battelle Memorial Institute recently disclosed the technical feasibility of induction melting reactive metals such as titanium. Unlike arc melting, the larger amount of heat from an induction coil is produced in the periphery of the melt. To avoid damage to, and electrical losses in the water-cooled copper crucible, this has to be segmented.

Battelle do not disclose what material is used to separate the segments, but the durability of this must be of prime importance. On a laboratory scale they have successfully melted commercially pure titanium charges about 2 in in diameter and 5 in long with a power input of 80 kW. Battelle visualise that it will be specially important for melting scrap from which impurities are scavenged in a single melt by the vigorous stirring action; also they suggest that this might allow continuous casting by withdrawal from the crucible, although there are formidable problems to be overcome in sealing in order to maintain the high vacuum required in the melting zone.

Continuous Flame Reduction:—One of the reasons for the high cost of titanium—despite the fact that the price could be halved if existing melting equipment in the UK were fully utilised—is that all the stages of its manufacture are batch processes. Backstepping to the process of obtaining sponge from titanium tetrachloride, this comment still holds good. Recent work reported in *I/EC*, June, 1959, vol. 51, pp. 738-8, by Fuhs of the California Institute of Technology is therefore of interest. This indicates that extraction of titanium with sodium, such as in the ICI version of the Kroll magnesium process, is definitely technically possible by establishing a diffusion flame of liquid sodium in an atmosphere of titanium tetrachloride vapour. The yet unexplored difficulty is of continuously extracting the sponge titanium from the reaction chamber.

Electrolytic Refining:—One of the problems which faced the titanium melters in the early days of the metal was the reuse of scrap. As an alternative to using unclassified waste material for deoxidising steel (an outlet with a comparatively low price attached to it), there now exists an electrolytic means of purification so that the resultant material is fit for remelting into ingot. This was developed in the USA by the Bureau of Mines (Report of Investigations 5314, 1957) and offers a technique for refining offgrade titanium sponge and scrap in a fused-salt bath. Improved methods of heating have been reported in a similar investigation, Report 5494, 1959. The electrolyte is fused sodium chloride containing from 2-7 per cent titanium chloride, and the electrolysis is performed under helium. Tests on a full-sized 4,000 A cell, such as shown in Fig. 2, have shown that with a feed of anodic metal with 0·1-1·0 per cent oxygen, 0·05-0·5 per cent nitrogen and 0·1-0·6 per cent iron, the final product with low titanium content of the bath, contained 0·022, 0·001, and less than 0·005 per cent respectively of the elements. This is quite suitable for remelting—more hope, therefore, for impure scrap which is otherwise of little value.

Ductile Molybdenum

Molybdenum has recently gone through a period of realistic criticism. Although its price is still out of this world it is unlikely to reach the moon in large quantities because it is not the exotic metal which it was built up to be. A problem still remains in preventing catastrophic oxidation above 500° C. Chromalloy Corp. in the USA seemed to have found an answer in the use of a surface treatment with chromium but latest comments imply that this coating cracks up and that oxidation continues. Perhaps it will go the way of titanium and will prove to be a useful down-to-earth metal, especially for chemical plant. Even in this sphere, however, it is not outstanding and other well-established metals like tantalum and titanium have more to offer. Once again it is the oxidation resistance which is lacking.

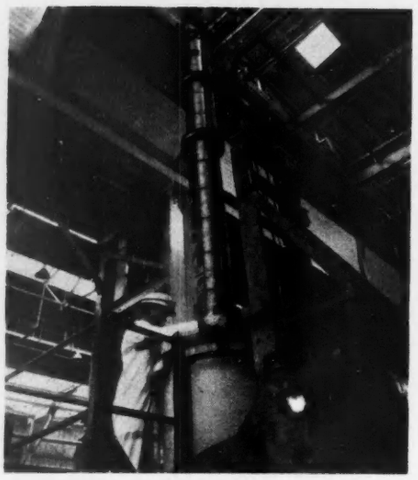


Fig. 1 Loading a 2,100 lb titanium consumable electrode into crucible prior to melting.

Molybdenum is made by powder metallurgy or arc casting methods, the latter being the most recent, and now applied in the USA to alloys such as the 30 W-molybdenum alloy made by Climax Molydenum Company. American General Electric have managed to improve the ductility of the metal five times in their powder method so that thin sheet can at least now be bent round a small radius at room temperature.

Arc Cast Sheet:—Semchyshen and Barr of Climax Molybdenum reported their work on making sheets from arc cast molybdenum and its alloys in Paper 108, Third Pacific Area National Meeting of the ASTM, California, 1959. Ultimate tensile strengths at room temperature varied from 91,300 to 105,000 lb per sq. in in the rolling direction and were similar at right-angles to it. Transition temperatures varied by as much as 100° F from sheet to sheet. 0·5 Ti, 0·05 Zr and 0·5 Ti-0·07 Zr-molybdenum alloys were made into $\frac{1}{16}$ in sheet. The last of these displayed best elevated temperature strength in both long and short term testing. Owing, the authors think, to surface contamination, the surface layers had higher recrystallisation temperatures than the interiors of the sheet which was more marked with the alloys.

Electrolytic Molybdenum:—Whether or not molybdenum can be developed into a useful engineering metal in its own right, it will always be used as an alloying addition to steels. For the quality demanded by such use, the Bureau of Mines laboratories at Reno, Nevada, have developed a new method of separating both this metal and tungsten directly from the tungsten mineral scheelite. The electrolytic bath, the centre of the process, contains alkali phosphates or borates. Molybdenum of 98 per cent purity comes out first on electrolysis, followed by tungsten of 99 per cent purity.

Massive Tungsten

If high melting point were the sole criterion for usefulness of a metal then tungsten would carry away all the laurels—its melting point of 3,410° C is the highest of all. The big drawback is making massive articles. Other than by powder metallurgical techniques, simple shapes have been made by hot forging at about 1,600° C

to produce items such as rocket nozzles but normally the metal is too hard and brittle to work at low temperatures. Two recent developments, however, promise well in solution of this problem. The first is the appearance of the plasma gun which permits building up massive metal by spray forming. Several plasma guns are now on the market in America made by such people as Linde Division of Union Carbide, Thermal Dynamics Corporation and Metco. By spraying on to a mandrel which is subsequently dissolved away Linde have succeeded in making crucibles, X-ray targets and the inevitable rocket nozzles.

Coatings or solid masses of metal made by the plasma process require sintering to obtain maximum density and are open to embrittlement by gaseous pickup during spraying. The second development seems even better. It has recently been reported by the Bureau of Mines laboratories in Rolla, Missouri who have written a report No. 5539 entitled " High-Purity Tungsten by Fluoride Reduction." The process then is one of vapour deposition in which tungsten is deposited from a mixture of tungsten hexafluoride and hydrogen gases when they pass near a hot surface. So far only tubes have been made since the tungsten deposited itself on the inside of the reaction chamber which is itself a cylindrical copper tube, but this can well be developed into more complex shapes.

Metal produced by such methods is of 99·99 per cent purity having a density (19·25) greater than that of commercial drawn tungsten wire (19·23). With the high efficiency of over 90 per cent reduction of the gases, and without the need or sintering, this process will surely be developed.

Tantalum and Niobium Need Careful Handling

In their applications in pure form, tantalum is old enough to be niobium's father: one firm in America made its first tantalum bayonet heater way back in 1937. Tantalum's cost is truly exotic but its corrosion resistance, which is even better than that of titanium, zirconium and niobium, is sufficient reason for its use. It will resist hot sulphuric, hydrochloric and phosphoric acids in all concentrations.

Tantalum and niobium usually occur together in their ores and their complete separation is very costly. This, unfortunately, is necessary for the main outlet envisaged for niobium, namely, sheathing of fuel cans for reactors working at temperatures of 700° C or higher. Tantalum has an absorption cross section twenty times that of niobium and is more suited for control rods.

Electron Beam Melting:—Both tantalum and niobium go through the stage of being a sponge or powder and require a melting or sintering process to make the massive article. For attaining high purity with respect to gases, the recently developed electron beam furnaces have greatly influenced the future of the two metals. Both this method and the normal arc melting methods were discussed at the Third Pacific Annual National Meeting of ASTM in a paper No. 117 by McCullough of Universal-Cyclops Steel Corporation.

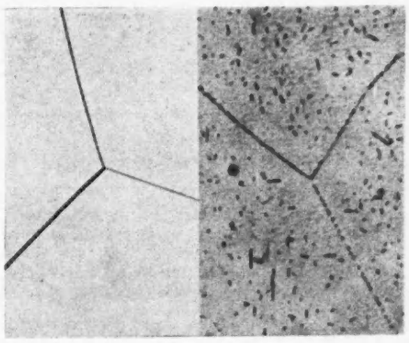
In the electron beam furnace, efficient transfer of energy depends on the attainment of high vacuum such as exists in a radio tube. The conditions are right for successful degassing and volatilisation of impurities such as titanium, zirconium, silicon and chromium and at a pressure of 0·1 micron this does in fact occur. In Fig. 3 is shown the microstructure of niobium melted by this process compared with that of the arc cast metal; oxides and nitride intermetallics are virtually non-existent. Where alloys must be prepared with volatile additions, this loss is a disadvantage, and Universal-Cyclops have used arc remelting of electron-beam-pure ingot as the stage to introduce the alloying elements. This corporation looks forward to casting 9½ in diameter tantalum ingots weighing 1,000 lb in the near future.

Niobium is being actively developed in this country by ICI. Although it has a high melting point of 2,486° C its oxidation resistance above 400° C is sadly lacking and alloying is being tried as a means of improving this. Although the metal is termed ductile and easy to process this is only of recent origin, for oxygen, nitrogen, hydrogen and carbon all harden it rapidly. 0·5 per cent oxygen, for instance, increases the hardness expressed in DPN from about 100-300.

Ductility:—In the paper mentioned above are recorded further experiences of Universal-Cyclops with this metal, including what is probably the largest niobium ingot which has ever been cast—9½ in diameter and weighing 343 lb. Both hot and cold working has been tried successfully on metal as clean as that whose structure is shown in Fig. 3, but for general working of large ingots the firm favour hot working at around the 1,000° C mark followed by very good surface preparation prior to cold work in order to prevent cracking.

Universal-Cyclops have successfully made alloys both directly from sponge and from pure electron

Fig. 3 Electron beam refined niobium (left) shows elimination of oxides and nitride phases compared with the arc cast metal (right). Magn. × 200.



beam melted niobium. A 400 lb ingot of 10Ti-niobium was cast by premixing titanium with the sponge, and a 500 lb ingot of 1Zr-niobium was made by twice melting a niobium ingot with strips of zirconium attached. Niobium has been extruded and 1½ in diameter stock cold rolled to ⅛ in diameter wire without annealing.

Promising Platinium Metals

Little has been published on the high temperature strength of these metals although their good resistance to corrosion needs little stressing. Cost is a trifle high, however, and this probably explains why Battelle workers used miniature test specimens in such evaluations reported in paper No. 111 at the ASTM meeting mentioned earlier. The authors were Holden, Douglass and Jaffee.

Tensile properties were obtained for rhodium, palladium, iridium and platinum from −196 to 1,000° C, and for ruthenium from 750 to 1,200° C. Ruthenium, reduced 10 and 30 per cent from the sintered bar, exhibited low (less than 1 per cent) ductility at 750° C, with tensile strengths up to 43,000 lb per sq. in. Strengths decreased with increasing temperature to about 20,000 lb per sq. in at 1,200° C with increased ductility.

Ductile Rhodium:—This metal, both as received and electron beam melted, exhibited tensile strengths decreasing from about 150,000 lb per sq. in at −196° C to 12,500 lb per sq. in at 1,000° C. Ductility values were high, although minimum values were found near 500° C, attributed to intergranular cracking.

The one lot of palladium tested was of commercial purity. Tensile strengths ranged from 63,000 lb per sq. in at −196° C to 1,850 at 1,000° C, with very high ductilities. Strain ageing behaviour was observed at low to intermediate temperatures.

One lot of iridium was badly cracked during fabrication, leading to erratic tensile results. Electron beam melted and sound material yielded tensile strengths ranging from above 100,000 lb per sq. in at −196° C to 45,000 lb at 1,000° C. Ductilities increased with temperature, reaching high values (80 per cent reduction of area) at 1,000° C.

Platinum, tested in commercial and high purity grades, showed strengths ranging from 75,000 lb per sq. in at −196° C to 3,400 at 1,000° C. Reduction in area values all were high (greater than 90 per cent). Strain ageing in the commercial purity grade was observed at low to moderate test temperatures.

It seems, therefore, that iridium and rhodium stand out from among this group of metals.

Beryllium and Zirconium

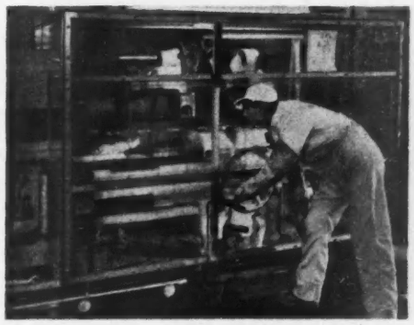
The future for both of these lies in nuclear power as canning materials and both are now in commercial production in this country. Their main use derives from low neutron absorption cross-sections, good conductivity and compatibility with uranium fuel rods.

Zirconium was launched quietly by ICI in this country and no difficulty was found in processing it in the same manner as titanium. Beryllium, on the other hand, has caused more trouble because of its toxicity and special facilities have had to be provided to prevent inhalation of beryllia dust by workers. One such installation is that of ICI Metals Division which was completed in a year at a cost of £10 million. Fig. 4 shows the guards built around a swarfing lathe which itself is situated in a plant which is completely air conditioned and heavily safeguarded.

Beryllium " Difficult ":—All the safety precautions demanded in processing beryllium foster the use of adjectives like " exotic." It is indeed a promising material but in metallurgical terms is nothing more than " difficult." Its main drawback is brittleness which defies normal metal forming at room temperature. The trouble is not gaseous impurities so much as the directionality of properties in the metal. Purification is carried out by induction melting in a beryllia crucible in a vacuum of about 300-500 micron (compared with 0·1 for electron beam work).

Attainment of small, random grains is produced not by melting and adding grain refiners as is standard metallurgical practice, but by grinding machined swarf to 200 mesh followed

Fig. 4 Safety guards to prevent inhalation of beryllia during machining.



by compacting and sintering. The UKAEA have achieved good results by the method of pressureless sintering reported in this journal in vol. 187, pp. 412-413 and 437-439. Such material has a strength of about 20 tons per sq. in with an elongation of 1 to 3 per cent, but this is improved by hot rolling to 40 tons per sq. in with an elongation of 10 per cent.

Trouble still exists in preventing coarse grains and brittleness in welds, but other metalworking processes demanded for fuel cans are rapidly being solved. Beryllium is being developed for the carbon dioxide cooled reactor and will withstand this gas up to 600° C if dry. It does not like water, however, and it is for reactors so cooled that Zircaloy was produced. Zirconium is not satisfactory with carbon dioxide, so the two metals are really complementary.

Plain Words

By Capricorn

Now is the time of year when those of us who live in Northern parts set about planning our holidays.

The propensity to planning being a mark of civilised man, we must always have something to which we are looking forward. For the last two or three months of the year we are obliged, whether we like it or not, to look forward to Christmas because the whole retail trade, aided and abetted by the mammoth manufacturers, wages a fierce campaign to drain us of our pounds, our shillings and our pennies. Then before we have had time to recover from the Christmas and New Year peak of festivity and trough of bills, we are yanked out of the mood of reaction by alluring advertisements of summer holidays.

From organised coach tours to the off-beaten track discoveries of mysterious travel writers, they are all designed to remove us temporarily from the mechanical and electrical environment that we have created for ourselves. The most sophisticated holidays are those which give the appearance and sense of being " away from it all," yet at the same time contrive to see that our needs are ministered to by machines that are unobtrusive and as discreet as an Edwardian butler.

From the Rolls-Royce with its perky electric clock ticking away, and the air ferry which holds us for only twenty minutes, to the French butane stove and the *pedalo*, our contacts with machines and other 20th Century equipment are carefully regulated in case they should let us down by mechanical failure and thus destroy the illusion of Paradise.

I have known men who go to the other extreme and pursue their engineering interests while on holiday. They seek out old locomotives or stationary engines and take photographs. But they are a special minority; most of us ordinary mortals like to clear our desks and seek the simple life.

The increasing popularity of camping in Europe and North America is one sign of this cult of the primitive. Paradoxically, it has been accelerated by the vastly improved equipment which modern materials and techniques have permitted. The crude tent and messy paraffin stove have been superseded by a highly-developed design of tent or a comfortable caravan, and by the little gas stove which gives instant heat or light.

These trends, I believe, are significant beyond just the holiday interests. They are perhaps the early signs of a coming expansion in the variety of aids to leisure. Motor cars, boats, golf clubs, climbing boots, skis—there are lots of them and most of them have been with us for many years. With so many recent advances in engineering generally, the way is open to imaginative designers to develop things which could not have been developed at an earlier date.

What are these things? I wish I knew, though if I did I would probably give up writing this column.

Letters to the Editor

Children of the Sun

SIR, ENGINEERING does not reach me until several weeks after publication, hence this letter is a little out of date.

I would like to suggest to Mr. Aldo Cassuto, relative to his review of Danilo Dolci's book *To Feed the Hungry* (ENGNG., 6 Nov. '59, p. 449), that one of the best reasons for engineers not being over-anxious to render aid to Sicily is contained in Morris West's book *Children of the Sun*.

How could anyone, not possessed of remarkable virtue, ignore the irresponsibility which apparently is so rife in the Italian and Sicilian administrations? What self-respecting engineer would associate himself with any work if he had reason to suspect that by so doing he was adding to the profits of " Lucky " Luciano and his henchmen?

A little more sincerity from the appropriate quarter would be of much greater avail than a free distribution of Dolci's work, great man though he is.

Yours faithfully,

D. J. GROSSE.

14 Nursery Drive,
Banbury, Oxon.
2 January, 1960.

NSU-Wankel Engine

SIR, The description of the NSU-Wankel engine given in the Press revealed sufficient information to calculate the internal shape of the cylinder. The diagrams given seemed to show two portions of the cylinder where the shape was concave outwards, one between the inlet and exhaust ports and one near the sparking plug. In order to examine this point in more detail the following analysis was carried out.

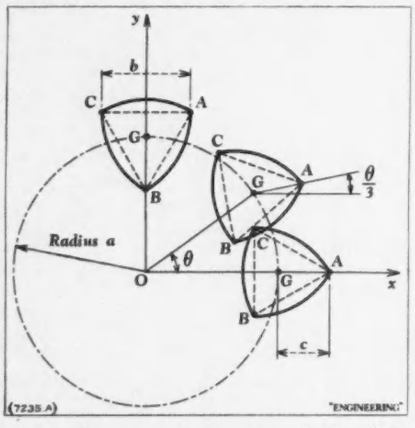


Fig. 1 Exaggerated geometry of the NSU-Wankel rotary piston engine.

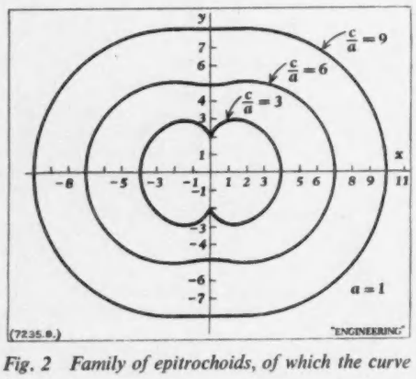


Fig. 2 Family of epitrochoids, of which the curve $\frac{c}{a} = 6{\cdot}4$ is probably used for the actual engine.

The rotor and the notation is shown in Fig. 1, in which the dimensions, particularly the eccentricity a, have been exaggerated for convenience. The rotor A B C is shown in three positions and the point G is the centroid of the equilateral triangle A B C. In the general position, the line O G is inclined at an angle θ to the x axis; the locus of A is therefore

$$x = a\cos\theta + c\cos\frac{\theta}{3};\quad y = a\sin\theta + c\sin\frac{\theta}{3}$$

This, according to Lamb (*An Elementary Course in Infinitesimal Calculus*, Cambridge University Press, 1949), is the equation of a particular epicyclic and also, according to Professor Baier quoted in ENGINEERING (25 Dec.'59, p. 676), a special form of an epitrochoid.

The point of interest occurs when $\theta = \frac{3\pi}{2}$, here $x = 0$. Hence, examining the equations for turning points by differentiation and equating to zero, there is a turning point at $\theta = \frac{3\pi}{2}$ provided that $\frac{c}{a} \neq 3$.

Proceeding to determine the nature of the turning point by a second differentiation, this shows that the turning point is a minimum provided $\frac{c}{a} < 9$; and a maximum if $\frac{c}{a} > 9$.

A family of curves has been constructed, which is shown in Fig. 2. It is seen that in the case $\frac{c}{a} = 3$ a cusp is present at $\theta = \frac{3\pi}{2}$, and in the other cases the appropriate maxima and minima are shown.

In the practical case the pitch circle of the rotor gear has a radius R_R and the output shaft gear a radius R_S. The gear ratio shown in the diagrams (ENGNG., 25 Dec. '59, p. 676) gives $\frac{R_R}{R_S} = \frac{3}{2}$, and from Fig. 1 $R_R - R_S = a$, hence, $R_R = 3a$ and $R_S = 2a$.

The maximum size of the rotor gear will be close to the case where the rotor gear pitch circle becomes the inscribed circle of triangle A B C. In this case, $R_R = \frac{c}{2}$ and therefore $\frac{c}{a} = 6$. Hence, $\frac{c}{a}$ for a practical engine will probably lie in the range $6 < \frac{c}{a} < \infty$. The value of $\frac{c}{a}$ estimated from the diagram given in ENGINEERING was $\frac{c}{a} = 6{\cdot}4$, confirming the conclusions.

Yours faithfully,

W. A. WOODS.

Department of Mechanical Engineering,
The University of Liverpool.
4 January, 1960.

Libraries in India

SIR, I am a regular reader of ENGINEERING and I find quite interesting references and materials in it and they are very useful to me.

As I read On the Shelf by Mr. Frank H. Smith for the 20 November issue (p. 513), I find the reference to librarians in the first paragraph very interesting. It is really a pity that they have such a lot of information and literature with too many " duplicates " in very many libraries, whereas here, it is very rare. I do not know whether these libraries can help me by sending me the information, viz., the journals that are surplus and are not required by them. Of course, it is too much of a sweeping request, but this is because of the dearth of information.

So any magazines, or any technical journals, however old and ancient they may be, still they are reckoned as useful to us and hence this

request. I do not know whether it will be possible for you to please request these people to let me have the journals which they can spare.

Yours faithfully,

R. RADHAKRISHNAN,
Senior Engineer.

Indian Telephone Industries Limited,
Bangalore 16, India.
6 January, 1960.

Events in Advance

Computation in Moscow

One substantial activity which is being undertaken by Groups A and B of the British Conference on Automation and Computation is the sponsoring of the British contribution to the first congress of the International Federation of Automatic Control (IFAC), which is due to be held in Moscow from 27 June to 6 July, 1960.

The number of papers submitted by British authors for reading at the Moscow congress considerably exceed the amount of time and space which have been allocated by the organisers of the undertaking. Arrangements have been made, therefore, for a British convention to take place on the same subject. It will be held in London in September next and the surplus of suitable papers will then be presented.

Further information concerning the Moscow conference can be obtained from the honorary secretary, Group B, BCAC, c/o the Institution of Electrical Engineers, Victoria Embankment, London, WC2. The arrangements for the British convention are being undertaken by the honorary secretary of Group A of the BCAC, whose address is c/o the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1.

These events are additional to the discussion on computer systems referred to below.

Exhibitions and Conferences

Computer Systems: Managerial and Engineering Aspects of Reliability and Maintenance.—Wed. and Thurs., 20 and 21 Jan., at the Institution of Electrical Engineers, London, WC2. Discussion meetings organised by the Institution's Measurement and Control Section in cooperation with the British Computer Society (under the aegis of Group B of the British Conference on Automation and Computation). Apply to the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Society of Chemical Industry, Conversazione.—Thurs., 21 Jan. (6.30 p.m.) at Battersea College of Technology, Battersea Park Road, London, SW11. Public view of conversazione exhibits from 9.30 a.m. to 3.30 p.m. on Fri., 22 Jan., at Battersea College. Organised by the Corrosion Group of the Society of Chemical Industry, 14 Belgrave Square, London, SW1. Tel. BELgravia 3681.

Power Farming Conference, National.—Tues., 9 Feb., to Thurs., 11 Feb., at the Town Hall, Cheltenham, Glos. Organised under the auspices of the *Practical Power Farmer*, Dorset House, Stamford Street, London, SE1. Tel. WATerloo 3333.

Induction Heating Course, Second.—Tues., and Wed., 1 and 2 Mar., covering theory of induction heating, how the generator works, and the design of coils for hardening, annealing, tempering, brazing and soft soldering. Organised by the Process Heating Division, Pye Ltd. Apply to Mrs. E. Raeburn, Pye Process Heating, 28 James Street, Cambridge. Tel. Cambridge 57590.

Exploration of the Moon, Symposium.—Sat., 5 Mar., (2.30 p.m. and 5.30 p.m.), at Caxton Hall, off Victoria Street, London, SW1. Organised by the British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Tel. TATe 9371.

Frankfurt International Spring Fair.—Sun., 6 Mar., to Thurs., 10 Mar., at Frankfurt. Agents: Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London, EC4. Tel. CENtral 5050.

Lyons International Trade Fair.—Sat., 12 Mar., to Mon., 21 Mar., at Lyons. Agents: Robert Brandon and Partners, Ltd., 47 Albemarle Street, London, W1. Tel. HYDe Park 0901.

Vienna International Spring Trade Fair.—Sun., 13 Mar., to Sun., 20 Mar., at Vienna. Apply to the British-Austrian Chamber of Commerce, 29 Dorset Square, London, NW1. Tel. PADdington 7646.

Industrial Photographic and Television Exhibition and Conference, Second.—Mon., 21 Nov., to Fri., 25 Nov., at the Royal Albert Hall, Kensington Gore, London, SW7. Organised by the Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Corrosion Exhibition.—Tues., 29 Nov., to Fri., 2 Dec., at Olympia, London, W14. Organised by *Corrosion Technology*, Leonard Hill House, Eden Street, London, NW1. Tel. EUSton 5911.

ACHEMA Chemical Engineering Exhibition.—Fri., 9 June, to Sat., 17 June, 1961, at Frankfurt. Organised by DECHEMA (Deutsche Gesellschaft für Chemisches Apparatewesen), 25 Rheingau-Allee, Frankfurt-on-Main, Germany.

Meetings and Papers

British Institution of Radio Engineers

EDINBURGH
"Micro Miniaturisation," by H. G. Manfield. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Fri., 22 Jan., 7 p.m.

Chemical Society

SHEFFIELD
"Some Recent Studies with Natural Products," by Professor E. R. H. Jones. Sheffield Branch. Chemistry Department, The University, Sheffield. Thurs., 21 Jan., 4.30 p.m.

Combustion Engineering Association

BIRMINGHAM
"Case for, and the Maintenance of, Mechanical Stokers," by H. E. Pearsall. Midland Region. Chamber of Commerce, New Street, Birmingham. Thurs., 21 Jan., 10.15 a.m.

Diesel Engineers and Users Association

LONDON
"Oil Engine-Driven Pumping Machinery," by P. F. Morgan. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 21 Jan., 2.30 p.m.

Illuminating Engineering Society

HULL
"Lighting for Ships," by P. Chittenden. Hull Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Tues., 19 Jan., 6.30 p.m.

Institute of Fuel

SHEFFIELD
"Oil Fuel and the Sectional Boiler," by G. J. Gollin. Yorkshire Section. Royal Victoria Hotel, Sheffield. Wed., 20 Jan., 2.30 p.m.

Institute of Physics

LONDON
"Health Physics," by H. J. Dunster. Education Group. Wed., 20 Jan., 6 p.m.

Institute of Road Transport Engineers

LONDON
"Air Suspension," by V. E. Gough. Metropolitan Area. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 21 Jan., 6.30 p.m.

Institute of Welding

LONDON
"Further Developments in the Welding of Atomic Plant," by A. Prince. Wed., 20 Jan., 7.30 p.m.*

Institution of Chemical Engineers

LEEDS
"Refrigeration Practice," by A. Perry. North Western Branch. Houldsworth School of Applied Science, The University, Leeds. Wed., 20 Jan., 6.30 p.m.

Institution of Civil Engineers

LONDON
"Sanitary Engineering in Germany," by F. Pöpel. Tues., 19 Jan., 5.30 p.m.*
"Development of Traffic Engineering in London." Discussion opened by A. J. H. Clayton. Traffic Engineering Study Group. Thurs., 21 Jan., 5.30 pm.*

Institution of Electrical Engineers

LONDON
"Reliability and Economy of Cable Installation." Discussion opened by W. Holttum. Mon., 18 Jan., 5.30 p.m.*
"Superseding the Ratio Arms in Alternating-Current Bridges." Discussion opened by C. G. Mayo. Measurement and Control Section. Tues., 19 Jan., 5.30 p.m.*
"One Approach to Generalised Machine Analysis." Discussion opened by J. G. Henderson. Education Discussion Circle. Wed., 20 Jan., 6 p.m.*

Institution of Engineering Designers

BRADFORD
"The Architect, Designer and Practitioner," by M. G. Riley. Yorkshire Branch. Midland Hotel, Bradford. Wed., 20 Jan., 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Impact of Air Conditioning on the Ship Designer." Discussion. Tues., 19 Jan., 6.30 p.m.

Institution of Heating and Ventilating Engineers

LEEDS
"Mechanical Stokers for Shell Boilers," by E. J. C. Macdonald and W. R. Douglas. Yorkshire Branch. Griffin Hotel, Leeds. Wed., 20 Jan., 7.30 p.m.

Institution of Locomotive Engineers

LONDON
"Some Aspects of Railway Braking," by R. C. S. Low. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 19 Jan., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"The Diesel Engine in Association with the Gas Turbine," by E. E. Chatterton. Meeting in conjunction with the Internal Combustion Engine Group. Wed., 20 Jan., 6 p.m.*
"Value of Hydraulics Research in Mechanical Engineering". Hydraulics Group Discussion. Thurs., 21 Jan., 6 p.m.*

Institution of Mining and Metallurgy

LONDON
"Serial Gravity Concentration: A New Tool in Mineral Processing," by J. H. Harris; and "Use of Moving Bed Ion Exchange in the Recovery of Uranium at Can-Met Explorations Ltd., Blind River, Ontario," by P. D. R. Maltby. Geological Society, Burlington House, Piccadilly, W1. Thurs., 21 Jan., 5 p.m.*

Institution of Plant Engineers

BLACKBURN
"Communicating with Others," by R. Gregory. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 21 Jan., 7.30 p.m.

Institution of Production Engineers

LONDON
"The Place of the Consultant in Industry," by A. D. Wilson. Royal Commonwealth Society, Northumberland Avenue, WC2. Thurs., 21 Jan., 7 p.m.

Institution of Structural Engineers

LONDON
"Lightweight Fire Protection and the Structural Engineer," by A. R. Mackay. Thurs., 21 Jan., 6 p.m.*

Junior Institution of Engineers

LONDON
"Developments in Engineering Education, Recently and to Come," by Dr. H. L. Haslegrave. Fri., 22 Jan., 7 p.m.*

Liverpool Metallurgical Society

LIVERPOOL
Student Prize Competition. Department of Metallurgy, Liverpool University, 146 Brownlow Hill, Liverpool 3. Thurs., 21 Jan., 7 p.m.

Royal Aeronautical Society

LONDON
"Some Aerodynamic Problems of Engine Installation," by Dr. J. Seddon. Tues., 19 Jan., 7 p.m.

Royal Meteorological Society

LONDON
"Experimental Studies of Wave-Form Clouds," by N. Gerbier; and "Recent Developments in Theoretical Treatment of Mountain Waves," by Dr. E. Palm. Wed., 20 Jan., 5 p.m.*

Royal Society of Arts

LONDON
"Function of Management in Industry and Commerce," by Sir Frederic Hooper. Wed., 20 Jan., 2.30 p.m.

Society of Instrument Technology

MIDDLESBROUGH
"Education of Instrument Engineers," by E. J. Charnley. Tees-Side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Thurs., 21 Jan., 7.30 p.m.

Women's Engineering Society

MANCHESTER
"Textile Printing: Beauty from a 'Gooy' Mess," by L. Morris and D. H. Eatock. Manchester Branch. Manchester College of Science and Technology, Manchester 1. Mon., 25 Jan., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institute of Welding, 54 Princes Gate, Exhibition Road, London, SW7. (KNIghtsbridge 8556)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
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Concrete Strength Near Freezing Point

By Dr. J. M. Plowman, A.M.I.C.E.

Concrete gains very little in strength until a critical "maturity" of 750° F-hr has been reached: thereafter it obeys the normal maturity law. Temperatures near freezing increase the critical value but the loss is made good.

Some years ago the author, developing the idea of "maturity" initiated by Saul[1] and Bergstrom[2], investigated the relationship between the strength of concrete, its age at testing and the curing temperature.[3] Maturity is defined as the summation of time in hours multiplied by temperature in ° F above a datum of 11° F. This work resulted in Plowman's law, which states that: "The strength of concrete is proportional to the logarithm of its maturity."

This law is true in different forms for both normal and rapid hardening Portland cements without additives within certain limits of temperature. With its aid it is possible to calculate the strength of a given concrete at any age and temperature or succession of temperatures (i.e. different maturities) provided that the strength at one maturity is known. Thus it is possible to calculate the strength of concrete at 28 days at normal temperature (64° F) from a 7 day strength obtained at a winter temperature of 45° F. The law may be stated in mathematical form:

The percentage of the strength obtained at a maturity of 35,600° F-hr (i.e. 28 days at 64° F) $= A + B \log \left(\frac{\text{maturity}}{1{,}000}\right)$ where A and B are constants dependent upon the quality of the concrete. For practical purposes there are two values for each constant, corresponding to the two ranges 2,500 to 5,000 lb per sq. in and 5,000 to 7,500 lb per sq. in.

The author's original work was carried out at temperatures between 11·3° F and 105° F and with ages up to one year. Subsequent correspondence showed the validity of the law for periods up to 11 years, but little or no information was available for ages less than three days. The tests here reported were designed to determine the strength-maturity relationship at ages varying from a few hours to 28 days. Earlier work has included results for cubes cured at temperatures below freezing after a period of 24 hours at 64° F. The present series includes results for cubes cured at approximately 36° F for the whole period after casting. This is comparable to concreting in winter thin floor or wall sections which are difficult to warm substantially above air temperature.

The greatest problem in testing specimens at ages of less than 24 hours is the weak state of the concrete which frequently tears away from the cube when withdrawing the mould, due to the suction between mould side and concrete face. Application of different types of mould oil and grease did not solve the problem, but an answer was found when tracing paper was used to line the mould. The paper was cut in the form of a cross the arms of which were bent up to form a five-sided open box which was placed within the standard steel mould and pressed flat against the sides. The cube was compacted by ramming in the normal way and, when demoulded, the steel sides came away readily from the paper box without injuring the concrete. It was then possible, with care, to pick up a cube at an age of one hour without deforming it. Altogether 48 cubes were cast from one batch; some were cured at 62° F and a relative humidity of about 95 per cent, and the remainder at a similar humidity and a temperature of 36° F.

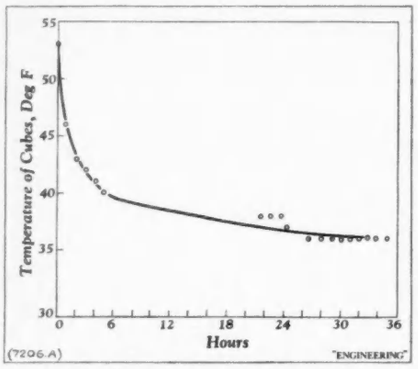

Fig. 1 Time-temperature curve.

To ensure that the second group of cubes reached the temperature of 36° F as rapidly as possible they were cast inside a refrigerator in moulds which had been kept therein for 24 hours. The temperature of the cubes was taken every half hour and from the resultant time-temperature curves the respective integrals (i.e. maturities) were obtained for the period until the cubes attained 36° F. The typical graph of Fig. 1 shows the rapid assumption of the final temperature. All cubes were demoulded after 24 hours if not previously required for testing, and replaced in similar conditions without delay.

The maturities at which cubes were tested were so arranged as to give a uniform spread when plotted on a logarithmic time base. Four grades of concrete were made, designed to have normal strengths at 28 days (35,600° F-hr) of 3,500, 4,500, 5,500 and 6,500 lb per sq. in, thus covering the range of concrete now cast on site. The mix proportions were identical for all grades and by weight were:

Portland cement	1·0
Sand	2·0
$\frac{3}{16}$ in to $\frac{3}{16}$ in Thames gravel	0·39
$\frac{3}{16}$ in to $\frac{3}{8}$ in Thames gravel	3·6

All materials and water were initially at 62° F.

Due to restrictions imposed by the number of moulds available and the refrigerator capacity, it was not possible to take the average of four results for each graph point. The lower-strength concretes were taken as an average of three results and, encouraged by the consistency of these figures, only two results for each maturity were obtained for the higher-strength concretes. The graphical results, Figs. 2, 3, 4, and 5, are all similar in shape, the curve having a very small initial slope at low maturities and a discontinuity at approximately 750° F-hr. The precise position of this discontinuity and its shape were not determined (since it would have required a 24 hour vigil), but it corresponds approximately to 14 to 15 hours at 64° F.

At greater maturities the curve becomes a straight line with a slope proportional to the quality of the concrete in the usual way. The values for A and B obtained from these curves are very similar to the average values of a large number of results previously published. It may be assumed therefore that the law is obeyed at ages greater than one day at normal temperatures.

Examination of the low-temperature curves shows a small deviation from the normal temperature curves. The discontinuity occurs at a greater maturity and the slope thereafter is initially greater than that for normal curing. This slope decreases until the two curves merge

Figs. 2, 3, 4 and 5. Strength-maturity curves for four concretes having nominal 28-day strengths of 3,500, 4,500, 5,500 and 6,500 lb per sq. in.

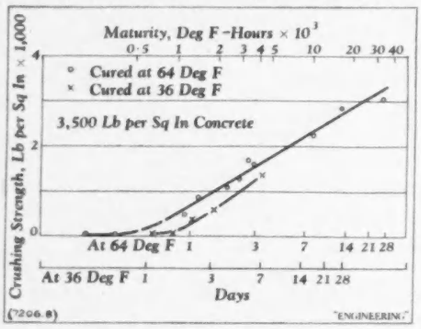
Maturity, Deg F-Hours × 10³
0·5 1 2 3 4 5 10 20 30 40
Cured at 64 Deg F
Cured at 36 Deg F
3,500 Lb per Sq In Concrete
Crushing Strength, Lb per Sq In × 1,000
At 64 Deg F 1 3 7 14 21 28
At 36 Deg F 1 3 7 14 21 28
Days
(7206.B)
"ENGINEERING"

Fig. 2

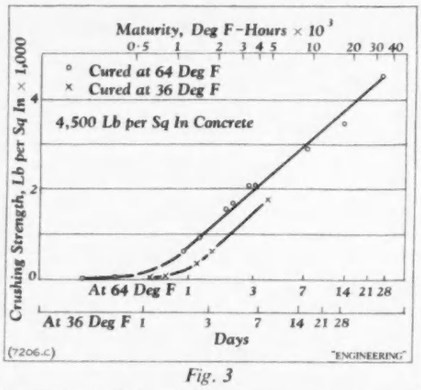
Maturity, Deg F-Hours × 10³
0·5 1 2 3 4 5 10 20 30 40
Cured at 64 Deg F
Cured at 36 Deg F
4,500 Lb per Sq In Concrete
Crushing Strength, Lb per Sq In × 1,000
At 64 Deg F 1 3 7 14 21 28
At 36 Deg F 1 3 7 14 21 28
Days
(7206.C)
"ENGINEERING"

Fig. 3

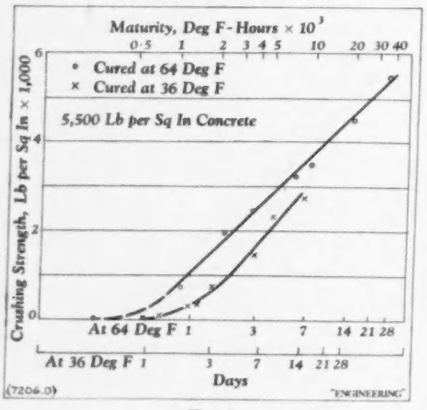
Maturity, Deg F-Hours × 10³
0·5 1 2 3 4 5 10 20 30 40
Cured at 64 Deg F
Cured at 36 Deg F
5,500 Lb per Sq In Concrete
Crushing Strength, Lb per Sq In × 1,000
At 64 Deg F 1 3 7 14 21 28
At 36 Deg F 1 3 7 14 21 28
Days
(7206.D)
"ENGINEERING"

Fig. 4

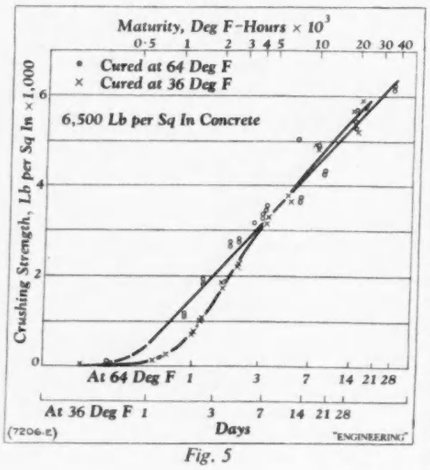
Maturity, Deg F-Hours × 10³
0·5 1 2 3 4 5 10 20 30 40
Cured at 64 Deg F
Cured at 36 Deg F
6,500 Lb per Sq In Concrete
Crushing Strength, Lb per Sq In × 1,000
At 64 Deg F 1 3 7 14 21 28
At 36 Deg F 1 3 7 14 21 28
Days
(7206.E)
"ENGINEERING"

Fig. 5

Hydroelectric Scheme Completed in Turkey

Turkey's longest river, the Kizilmirmak, has been successfully dammed and a 110 MW generating station established at Hirfanli. The scheme was officially opened by the Turkish Prime Minister on 8 January. Two British contractors, George Wimpey and Company and the English Electric Company, have been responsible for the work; consulting engineers to the Turkish State Water Board were the American firm of Tippetts-Abbett-McCarthy-Stratton. Cost of the project is put at £23 million.

The development is part of a nation-wide scheme for interconnected power grids, mainly fed by hydroelectric works and designed to meet over 60 per cent of the country's needs. In addition, Hirfanli will provide a holiday resort for Ankara, the capital, 90 miles to the south-east, and behind the dam the new lake, 46 miles long and 9 miles across at its widest point, will be used for sailing, fishing and bathing.

Civil work included the earth and rock-filled dam, 85 m high and 366 m long, the largest of its type in Europe, and the reinforced concrete power house and water intake. All the structures have been designed to withstand the earthquakes and 120 mile gales to which the area is subjected on occasions. To enable the dam to be constructed, two diversion tunnels had to be driven to carry the river. They were 23 ft in diameter and about 550 yards long, and both were sited on the right bank. The central portions of the tunnels have since been enlarged to 26 ft diameter and concrete lined to act as power tunnels taking water to the turbines. Part way along their length, each tunnel now divides and from thereon they are steel lined and bitumen enamelled to an inside diameter of 16 ft 9 in.

The electrical and mechanical equipment was made in Britain. It includes the three vertical 44,000 h.p. reaction turbines plus their alternators, the 60 ton butterfly valves (which were shipped to the site in one piece), the main and auxiliary transformers and the switchgear. The layout of the instruments and operating gear in the control room was designed to allow the whole scheme to be supervised by one man.

Ultimately Hirfanli will be used to feed water to four more generating stations that are to be built further downstream. The capacity of the completed project will then be 1,500 million kilowatt-hours per annum. A grid system now under construction will supply surrounding towns and villages, including Karabuk, Turkey's new industrial centre, where a connection will be made with the existing power lines from Ankara.

Concluding Concrete Strength

at a maturity of 6,000 to 7,000° F-hr. Further work is required to clarify and amplify this phenomenon but these incomplete results are put forward in the belief that they may be of some value to other engineers.

It is well known that the hardening of Portland cement is a chemical reaction and that the rate of hardening is influenced by the temperature. It is also known that temperatures near boiling point change the nature of the reaction so that the rate of hardening differs from that at lower temperatures.[4] From these few results it would appear that temperatures near freezing have a slight retarding effect on the growth of strength at early maturities. Values obtained by Price[5] do not show clearly such a trend at 40° F, so presumably the effect only occurs near 32° F. This phenomenon may indicate that one of the chemical reactions involved in the hardening of concrete is accelerated by a reduction in temperature, but that the commencement of this reaction is delayed until the cessation of a second reaction which is itself retarded by low temperatures.

CONCLUSIONS

1. Portland cement concrete obeys Plowman's law at temperatures near 60° F after 24 hours.
2. At temperatures near 32° F the growth of strength is retarded, this delay being made up after periods of about 7 days.

The above research was carried out while the author was a member of the staff of King's College, London.

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[1] Saul, A. G. A., p. 127, *Magazine of Concrete Research*, No. 6, 1951.
[2] Bergstrom, S. G., p. 61, *Magazine of Concrete Research*, No. 14, 1953.
[3] Plowman, J. M., p. 13, *Magazine of concrete Research*, No. 22, 1956.
[4] Narayanan, N. S., University of London, M.Sc. thesis, 1959.
[5] Price, W. H., p. 417, *Journal of the American Concrete Institute*, vol. 22, No. 6, 1951.

Railways into Roads in Norfolk

The recent announcement that Norfolk County Council and the Ministry of Transport were considering the conversion of some disused railways into trunk roads will give new impetus to Brigadier Lloyd's suggestion that Britain's railways as a whole should be changed into a reserved roadway system.

The present proposal takes advantage of all that was best in Brigadier Lloyd's scheme and contains none of the features that gave ammunition to his critics. First of all, the lines have already been abandoned as successful railways so no traffic will be inconvenienced while the conversion is being made. As part of a normal double track, the existing levelled and drained formation will provide ample width for a 24 ft carriageway, which will be something better than the 22 ft of two-thirds of the trunk roads in England. In addition, the formation will have been consolidated by time and traffic—a combination that road builders dream of. The alignment is excellent and the gradients easy. Moreover, the public inquiry should be straightforward, as there is unlikely to be the familiar mass of objections from the variety of private individuals that is customary when new road schemes are published. In this case the farming interests (frequently the biggest objectors to road extensions) sold out long ago.

The railway lines involved in the present discussions are all part of the old Midland and Great Northern. As roads they will provide additional routes from the Midlands into Norfolk, just bypassing King's Lynn. An estimate puts the cost of the conversion at some £900,000 for about 30 miles of road, most of which would qualify for a Ministry of Transport grant of 75 per cent.

Yorkshire Extension to the Motorway

The new draft scheme for the Yorkshire extension of the Motorway (M1) is for a "compromise" line put forward by the Leicestershire County Council to meet the objections raised by agricultural interests when the original route was published. The line now runs for 86 miles roughly northwards from Crick, near Rugby, to a junction with the Doncaster bypass, which is due to be finished in June, 1961.

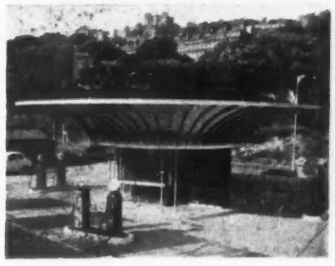
At the same time it was announced that proposals are soon to be published for an extension of the motorway into the West Riding towards Sheffield and Leeds, and for a spur from Catthorpe in Leicestershire to join ultimately with the Birmingham-to-Lancaster motorway.

The acceptance by the Ministry of Transport of the revised line for the Yorkshire extension of the motorway must be considered something of a victory for the agricultural community: quite a lot has been sacrificed in alignment and efficiency of the new road in order to save some amenities and farming ground. The conquest will give more strength to those who object to the claim on land made by six lane motorways. Last autumn, the Minister of Agriculture made a strong plea in public speeches for new motorways to have only two lanes (instead of three) in both directions. Frequent publicity has also been given to the fact that most Continental express routes make do with only two lanes in each carriageway. Those who attempt to make use of this to restrict the size of Britain's new motorways are overlooking the much higher density of traffic on roads here.

Aluminium Canopy for Circular Building

The illustration shows aluminium used in an unusual design for a petrol station canopy recently completed at Dover. The canopy is an inverted truncated cone with concave sides cantilevered out from the top of the attendants' central kiosk. It was designed by Aluminium Alloy Fabrications Limited, of Woking, Surrey, who also made and erected it, in conjunction with Louis Erdi, architect, of 27 Knightrider Street, London, EC4.

Under uniform loading, the 52 evenly spaced ribs act as arches between an outer tension and an inner compression ring. In the event of uneven loading, caused by snow on the one side and wind acting upwards on the other, the ribs act as cantilevers. Annular in plan, the canopy has an outside diameter of 50 ft and an inner diameter of 22 ft. The inner ring is a built-up steel box formed from two 8 in by 3 in steel tubes. The outer ring is made from 6 in by 3 in steel channels welded at the joints. The rib profile is formed by two curves giving a depth of 8½ in at the inner diameter and 4 in at the perimeter; Noral sections curved to shape have been used for the ribs and riveted to twin webs of 16 s.w.g. sheet with Tucker "Pop" rivets.



This petrol station canopy is made extensively of aluminium alloys in the form of extruded sections, and flat and embossed sheets.

Three-quarter inch steel plates riveted between the webs and then welded to the steel rings secure the ribs in position.

The roofing sheet is of stucco-embossed circular corrugated aluminium sheets cut to fit between the ribs and laid with the corrugations at right-angles to them. This not only provides lateral stiffening to the top section but also supports the weathering skin of 22 s.w.g. Noral; roofing felt laid between the sheets will eliminate chatter.

Research Scholarship on Light Alloys

A research scholarship in the use of light alloys in structural engineering is offered every third year by the Institution of Structural Engineers in collaboration with the Aluminium Development Association. The duration of the scholarship is two years and the value £600 per annum.

The next award will be made this year to date from 1 October, 1960.

Details and application forms are obtainable from the secretary of the Institution of Structural Engineers. Completed application forms should be sent in to reach the secretary by 31 March, 1960.

British Contribution to Motor Racing

Not only cars, but engines and components have helped to make the British reputation in motor racing. Commercial prestige follows successes on the track.

By Gordon Wilkins

In answering the question " Why do the British win motor races?" at a recent press conference, Commendatore Enzo Ferrari paid tribute to the part the British suppliers of materials have played in establishing British supremacy in international motor racing, and also for the help they give to rival teams. He said " People do not realise how much we are dependent on the British in the development and operation of our own cars." He went on to thank Shell and Dunlop in particular and added that if Mr. Vandervell had not supplied the special thin shell bearings which enabled Ferrari engines to run up to 9,000 or 10,000 r.p.m., they would probably never have achieved the power output and reliability they did.

The achievements of British brake manufacturers in establishing undisputed supremacy in international motor racing are now beginning to produce results on a commercial scale. Dunlop disc brakes are to be made under licence in France and Germany, Lockheed brakes will probably be made in Germany and other licence agreements may be expected to follow. Girling are already supplying Continental companies. France's fastest car, the Facel Vega and Germany's most powerful closed car, the 3·2-litre BMW, are already offered with disc brakes of the British fixed-caliper single-piston design. In Italy, the Maserati 3,500 and 5-litre, and the Lancia Flaminia and the Ferrari 250 GT, are all offered with British disc brakes. In the braking field the British technique seems to have established a clear lead and Continental efforts seen recently seem more cumbersome, more costly or less efficient.

The brake story goes back far beyond the introduction of discs of course. Automotive Products must have obtained great benefit from European licence agreements covering Lockheed patents and Girling have long supplied drum brakes to Alfa Romeo.

In the design of suspension dampers, British manufacturers have also obtained prestige and valuable practical experience from their participation in motor racing, but with the production volumes involved in European industry, the benefits can only be obtained through licence agreements. Armstrong are such an example, with their dampers being made under licence in France for Simca. It is a frequent subject of complaint from manufacturers of competition cars in European countries that they cannot always obtain the combined telescopic damper and coil spring suspension units which have become almost standard equipment on British racing and sports racing cars.

But probably the biggest success has been scored by Vandervell with the Vanwall thin shell bearings. These are now fitted as standard equipment by vehicle manufacturers of 13 nations; in France by Berliet, Hotchkiss, Simca and Peugeot among others; in Italy by Fiat, Alfa Romeo, Lancia, Maserati, Ferrari and OM; by Daimler Benz, BMW and Porsche in Germany; in Sweden by Volvo, SAAB, Scania Vabis; and in Holland by Van Doorne.

British carburettor manufacturers also supply some original equipment in small quantities ; for example, both Zenith and SU send carburettors to Volvo and SAAB.

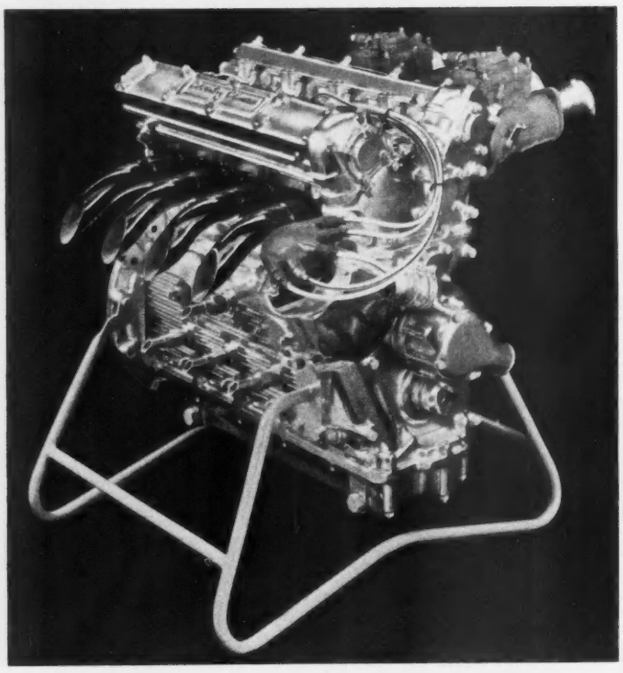
British transmission developments have not been so successful on the European market. The successful Laycock de Normanville overdrive was adopted by Simca on their V8 Vedette, but in a rather complicated installation which was presented to the buyer as a semi-automatic transmission and it has not apparently found many buyers. Europe has at present no locally designed automatic transmission in production, but is showing no inclination to buy the Borg Warner which equips so many British cars.

The reluctance to buy overdrives stems partly from the Continental manufacturer's tendency to gear higher than British manufacturers, sacrificing top gear flexibility in order to obtain fast top gear cruising at relatively low engine revolutions. This may be taken to the stage of making third speed in a four-speed gearbox the direct drive and gearing up the fourth speed. It also leads to the fairly widespread use of synchromesh on first gear, still a rarity in England. Here we tend to regard it as an emergency ratio; on the Continent it is used more often for starting and for mountain driving.

There are many other companies participating directly or indirectly in the prosperity of the European motor industry through licence agreements, not all of them as a result of motor racing. Among the current agreements which Wilmot Breeden have is one for the manufacture of their new Zero-Torque door locks in Italy, where they are being fitted on the Fiat 1800 and 2100, and they also supply door locks to Volvo. Metalastik also have a number of European agreements for the use of their techniques in engine mountings and other applications of rubber in car construction.

In his statement, Ferrari went further, revealing that he had also had to rely largely on the British metallurgical industry for some of his materials. Acknowledging the help received from Britain he asked: " Who gave us a licence to make zirconium? Who supplies titanium? Who provides us with Nimonic for valves?"

" The British accessory and component industry has dedicated itself to motor racing and it is only fair that they should reap the reward of their efforts."



Developed from a fire-pump engine, the Coventry Climax 2½ litre racing-car engine (left) has won for its makers the Ferodo Gold Trophy (right).

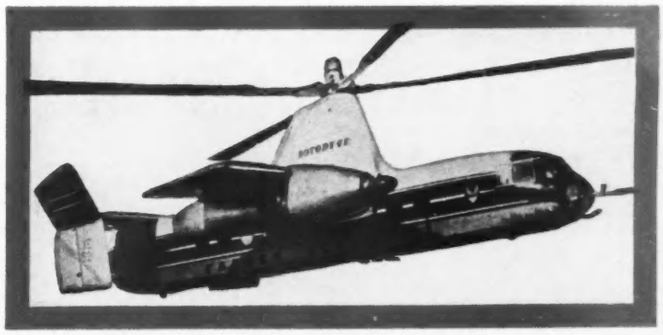
Racing Engine Honoured

For the first time the Ferodo Gold Trophy has been awarded to an engine manufacturer—Coventry Climax Engines Limited. The trophy, which was won outright last year and has been replaced by a new and striking design, is awarded by an independent panel for the most outstanding British Commonwealth contribution to the sport of motor racing during the year.

The panel's reasons for selecting Coventry Climax were given in the official citation to the award: " This firm, through the inspiration of their chairman and managing director, Mr. Leonard P. Lee, built all the engines used by Cooper Cars Limited to win the World's Manufacturers' Championship for Formula I. It was in Cooper-Climax cars that the World's Drivers' Championship was won by Jack Brabham." In thanking Ferodo for the award, Mr. Lee mentioned that in 1960 he would be racing the same FPF engine as in 1959. There were important changes which Coventry Climax would like to have made as a result of the experience gained during 1959 but, unfortunately, the change from a 2½ litre to a 1½ litre formula for 1961 Grand Prix racing did not make it worthwhile to redesign the engine again. But they were hoping to introduce a 1½ litre four cylinder engine in 1960 to prepare the way for 1961.

The development of a racing car engine from the fire-pump engine by Coventry-Climax is a familiar story. The FPF Grand Prix engine is a 2½ litre 4-cylinder twin overhead camshaft engine developing a maximum torque of 212 lb-ft at 5,000 r.p.m. Special features of the engine include the use of balance weights on the crankshaft made of GEC heavy alloy, a sintered metal much denser than lead; laminated metal sealing rings on the top of each cylinder liner to help secure the cylinder head gasket seal (the cylinders are very closely spaced); and the bracing of the base of the engine by 16 studs screwed horizontally (8 each side) into the five main bearing caps.

all the skill that went into THIS...



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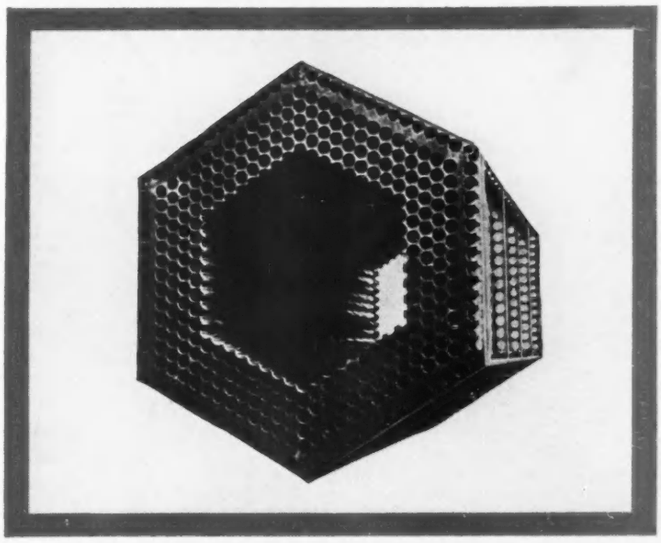

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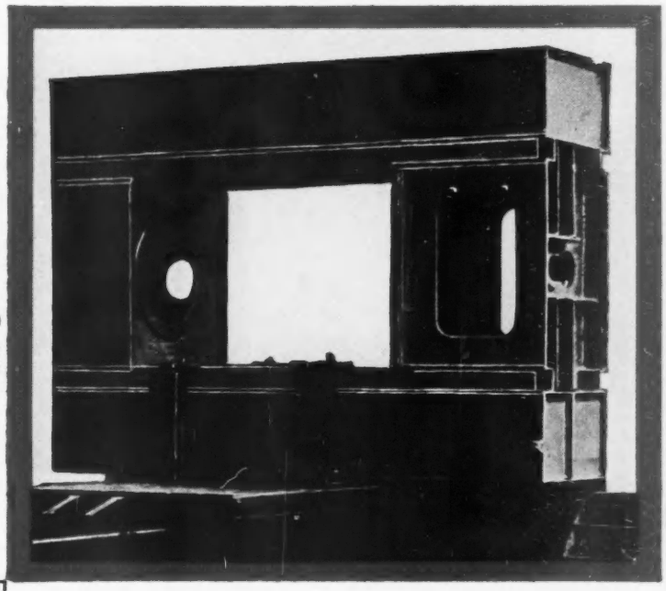

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Pyrites	Alumina	Coconut	Banana
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The Troublesome Rank and File

The technique of calling unofficial strikes just as wage negotiations are being concluded is spreading fast.

On top of the threat by the London district council of the National Union of Railwaymen to strike for a day, February 1, in support of their pay demands, comes the unconstitutional call by shop stewards last week end for one-day, or possibly one-hour, strikes in the engineering industries. The employers are due to reply on 26 January to the renewed claim by the unions for a £1 a week rise and a 40 hour week. They have already rejected the wages claim and offered to reduce the hours to 42½ a week.

The token strikes urged by a section of the more militant shop stewards would be unconstitutional and against the tone of the public pronouncements of such union leaders as Mr. Frank Foulkes, president of the Confederation of Shipbuilding and Engineering Unions.

Mr. Foulkes, who as a communist and as president of the Electrical Trades Union has something of a reputation as a top level militant himself, has taken a very delicate line indeed over the present critical negotiations. He has not only spoken against strikes but also against meetings in working hours. Mr. George Barratt, general secretary of the Confederation, told ENGINEERING: "Strikes are at the decision of individual unions and not district committees of the Confederation. There is no way in which a dispute could properly arise before our meeting with the employers on January 26."

It is only a matter of weeks since militants in the electricity supply industry organised the largely abortive one day stoppage at certain power stations when wage and conditions negotiations were already well advanced. In that case, as in the possible London rail strike, the local leaders, in a heady atmosphere of publicity and personal importance, were fighting their own union leaders as well as the industry, perhaps with more serious damage to the former.

At a time when many union leaders see the importance of their continued recognition as a responsible part of the nation's leadership, and when it is not yet known whether the post-election Government will so readily invite the Trades Union Congress chiefs across the doorstep of No. 10, warlike cries from the unions' own particular backwoods are about the last thing that will benefit their interests.

Keeping the NUR on the Rails

The job Mr. Sidney Greene has to do as secretary of the National Union of Railwaymen is particularly difficult.

It is widely stated among his members that some railwaymen are now earning 30*s* a week less in overtime. Indeed it would be a little odd for a modernisation scheme not to make it possible for increasing numbers of men to work only their basic hours. What the modernisation scheme has not yet done is to improve the Transport Commission's finances to the point where the railwaymen can be paid a wage where overtime is not a necessity.

The last rail pay increase was in the summer of 1958. In the December of that year the committee led by Mr. C. W. Guillebaud began investigating the whole complicated field of railway pay. Well into 1959 the NUR leadership, facing mounting pressure from its members, and with the Guillebaud report running far behind schedule, submitted a pay claim for a substantial increase. This the British Transport Commission has turned down on the grounds that it cannot afford to give increases. Late March or mid-April is now the estimated time of arrival for the Guillebaud pay investigation report.

Understandably there is doubt about the outcome among the rank and file. Sir Brian Robertson's promise that any pay award will be back dated to January 11 may do some good, but many railmen will want it back dated to somewhere in 1959.

What is the BTC to do if the Guillebaud report says roundly that a national asset such as the railway system may just now be running at a loss but that is no reason for paying the men less than they could earn in comparable outside employment? What happens if Sir Brian Robertson takes that poser to Mr. Marples, the Minister of Transport? Mr. Marples is said to have learnt more about traffic in three months than his Ministry experts who have been with the problems for years.

While that may not be as impressive a feat as it sounds it would take Mr. Marples infinitely less than three months to discover what sort of an uproar a direct rail subsidy would touch off in his own party. At least one political reputation was helped by making the trains run on time. Mr. Marples may yet help his along by finding a better way of paying the men who run them.

Apprentice Standards in Electricity Supply

A word of warning on the position of student engineering apprentices in the electricity supply industry has been given by the Electrical Power Engineers' Association.

Over the past five years, says the association, there has been a fall in the number of graduate trainees from 143 to 42, and only five of them are holders of degrees. This surprising fall, in an industry so well endowed with corporate engineers, was going on while the number of student apprentices was rising, over the last four years, from 1,500 to 2,124.

Closely linked with the employment policies of the electricity supply industry is the question of the career opportunities before the ambitious engineering student. The Electrical Power Engineers' Association regrets the action of the Institution of Electrical Engineers in tightening up their rules and requirements in such a way that the path to corporate membership for higher national certificate holders while not blocked may be described as very narrow.

The Association has made it known that it would like the Electricity Council to ask the Institution to re-examine its requirements and perhaps make them rather less stringent, at least while the present shortage of professional engineers lasts.

It is fair to observe here that this business about a shortage of professional engineers, while being hallowed by long and frequent repetition, is also a matter of discussion rather than undisputed fact. What, perhaps, the association should be asking the Electricity Council to urge (or why not do the persuading itself ?) is that the reversal of this drop in graduate trainees in electricity supply be brought about in the interests of a more efficient supply industry.

Practical Training for Top Executives

Presidents, vice-presidents and company secretaries of United States firms are among those who attend the practical training courses of the Training and Research Institute of the American Foundrymen's Society, the technical society of the metal castings industry.

Four-fifths of the companies making use of the Institute's courses operate foundries. The courses, held in many of the industrial areas of America and Canada, are aimed at improving the skill of operating management and line supervision, and of technologists and engineers. Thirteen per cent of the students have been drawn from administrative management, 6 per cent sales engineering, 18 per cent process control and the rest, more than half, from production.

The Institute's course director, Mr. S. C. Massari, explained; "1,200 men have been sent by more than 500 companies. Over 40 per cent have attended two or more courses, some as many as five. These repeaters are our best evidence that the courses fill a real educational need in this industry.

"An interesting development is the number of students from large corporations with their own extensive training programmes. The answer probably is that a continuous plant programme is not flexible to sudden needs for upgrading, indoctrination of new supervisors, and special assignments."

The Institute added 16 new classes to its list this year. They now include casting design and stress analysis, blueprint reading and estimating, foundry plant layout, metallurgy of ferrous alloys, metallurgy of light and copper base alloys, purchasing of foundry metals and welding and brazing of copper castings.

Engineers from Europe, South America, Mexico, Canada and 35 states of the USA have attended the courses. On top of its own permanent staff, the Institute obtains the occasional services of authorities in industry, engineering colleges and universities.

Northern Ireland Aircraft Employment

Mr. Duncan Sandys, Minister for Aviation, recently gave MP's from Northern Ireland an assurance that the importance of the aircraft industry in the economy of Ulster would not be overlooked in any decisions that might be taken on the reorganisation of the United Kingdom's aircraft industry.

Three MP's, Mrs. Patricia McLaughlin, Belfast West, Mr. S. McMaster, Belfast East, and Mr. W. Stratton Mills, Belfast North, had called on the Minister.

While Mr. Sandys did not feel he could guarantee any particular level of employment at Short and Harlands he told the MP's that he recognised the position held in Northern Ireland by the industry. He believed that if the Britannic could be built successfully and, no less important, in time, Shorts ought to be able to find an important and valuable market for the aircraft.

With major mergers going forward in the aircraft industry and others forecast it is easy for Ulstermen to fear that rationalisation could cause the withdrawal to the mainland of one of their all too few employment "bankers." The assurance from Mr. Sandys will, it is to be hoped, stand long into the future.

Coal Questions for TUC

The situation of the coal industry and those who work for it is nothing if not complex.

The TUC production committee now has the unenviable task of looking in some detail at the probable cost of the measures to mitigate the miner's lot which were put to the TUC by some of the senior executive leaders of the National Union of Mineworkers.

From financial assistance towards the cost of stocking unsold coal, redundancy and re-settling help and converting electricity undertakings from oil to coal, to ending open cast coal contracts and re-examining the atomic energy power stations programmes, the NUM's proposals are bound to be costly and not necessarily helpful in forwarding the country's industrial health.

Provision of alternative industrial occupation in the mining areas is the one sure and generally beneficial proposal and it is the one the union could have concentrated on with greatest hope of public support. For an industrial nation to cramp the economic choice between oil, coal, and in the case of the gas making industry, methane, is to assume that the economics of the nursing home apply to world trade.

The NUM leaders received no support from Mr. Richard Wood, Minister of Power, when they took their pro-coal policy to him, so while the TUC are expected to approach the Government for a meeting it is uncertain just who they will ask to see. Meanwhile the entrenchment in open cast coal getting, which was the most profitable way in which the Coal Board could get coal, is proving as uncertain as it is costly.

Opencast

In Derbyshire the Coal Board have abandoned plans to prospect for opencast coal on 31 sites.

Sir James Bowman, chairman of the NCB, announced this in a letter to Mr. G. H. Oliver, the M.P. for Ilkeston. Mr. Oliver, observing that more information from the NCB is likely to be wanted from local interests, said that few people would be prepared to develop land they knew might be wanted again.

Thus the Coal Board loses money and the benefit it might have gained and the abandoned sites suffer, or so the local M.P. believes, from the shadow of a future revival of demand.

Since at the end of the year coal production was running something under a million tons behind demand it may be that 1960 will see the 50 million ton coal stocks shrinking away. Even if they do the miners are never likely again to have the confidence that they were persuaded into in the last decade.

European Energy Policies in Perspective

A common need to solve the conflicting coal, oil and electric power problems of Europe may lead to cooperation between the continent's differing trade groups.

In the discussions on European integration, whether in terms of bridges between the Six and Seven, or of some sort of Atlantic Community, the problem of the coordination of energy policies is a critical one. No country, however well provided with energy sources, can avoid the implications of the changes that are taking place in the energy position. On the demand side the current forecast of the 18 OEEC countries (which include the Six Euratom Members) is of an annual increase of from 2½ to 3 per cent in energy requirements. This forecast is well on the conservative side as the average increase over the past ten years has been between 4 and 5 per cent a year and in some countries has been as high as 10 per cent. By any reckoning it seems clear that by the year 2000, Western Europe will need at least four times as much energy as it uses at present.

Within this global total the demand for different types of fuel will vary considerably, as will the proportions of total energy requirements met by importing fuels from outside Western Europe. A bare three years ago the Hartley Report forecast a shortage of energy. Since then, as a result of various changes on the demand side, notably the slowing down of industrial production in 1957-58, two mild winters, the movement for clean air and other factors making for a changeover from coal to oil, together with the greatly improved supply of oil, the position has changed from scarcity to surplus. The forthcoming report of the OEEC Committee under the chairmanship of Professor Austin Robinson is likely to tell a very different story from its predecessor. The need for coordination of policies remains. What are the problems in its way and are they likely to be overcome?

BALANCE UPSET

The first problem, and in many ways the most difficult, occurs where the traditional fuel balances are upset. In its most extreme form this is seen in Germany where the coal owners and trade unions have forced the Government to agree to impose a tax on fuel oil. The other big coal producing countries, including Britain, are faced with this problem of what to do with surplus coal stocks and how to transfer labour from coal mining to other industries with the least social and political upset. In France the emphasis is all on the development of Saharan oil and natural gas. In Italy the object is to increase home production of oil and natural gas. And apart from the conventional fuels of all kinds there are the nuclear energy programmes of the West European countries. One result of the Hartley Report so far as Britain is concerned, was to turn nuclear power station building into a crash programme. Other countries speeded up nuclear development also. Now the countries of Western Europe are faced with the fundamental engineering problem of organising the resources available to the best advantage for the people who use them. Unfortunately, there seems to be some danger that the process may be reversed and that it may be the consumers who are organised to fit the resources available.

How has the present situation developed? At the beginning of the century industrial production was based almost entirely on coal. The black patches denoting coalfields on the maps included more or less all the industrial regions. Hydro-electric power and petroleum products came into use fifty or so years ago, but were rarely in direct competition with coal. And Europe, through the coal exports of Britain and the Ruhr, was one of the great power sources for more remote parts of the world. The first major change started with the 1926 coal strike, after which Britain lost markets to Germany and Poland. The increasing use of fuel oil at this time for merchant ships and warships brought coal into direct competition with oil, and by 1939 had produced a situation in which Europe as a whole was about balancing its exports of coal with its imports of oil and American coal.

AFTER THE WAR

At the end of the war, Western Europe's energy production was no longer sufficient for its needs. The destruction of mines, oil refineries and power stations was made good, partly as a result of Marshall Aid, partly through the measures taken by national governments.

The Winfrith Heath, Dorset, Atomic Energy Establishment site where Dragon, the 10 MW high temperature gas cooled reactor, is to be built as a joint project of the European Nuclear Energy Agency of OEEC.

The period of reconstruction and renewed industrial activity showed that the West European countries as a whole were chronically short of energy. As a result, the coal industry was given high investment priority and the miners climbed to the top of the wages hierarchy in most European countries. In 1952 the European Coal and Steel Community carried this process further and freed trade in coal between the six member countries. It also set in train the movement for closer integration of the Six leading up to the Common Market and Euratom, and introduced for the first time the concept of the supra-national High Authority with powers to plan and coordinate the policies of member countries.

In May 1956 the Hartley Committee report *Europe's Growing Needs of Energy—How Can They be Met?* came to the conclusion that Europe would be dependent on imported fuels to a dangerous extent, and that the particular fuel accounting for most of the imports would be coal. The fact that this forecast was so wide of the mark has complicated the problem of forecasting future needs and of deciding how policies are to be coordinated in the future, or indeed what these policies should be. It has also made it easier for vested interests, in the Western European coal industry, for example, to raise their voices in favour of hampering further development of oil. An argument that is being increasingly heard is that as the ECSC imposes obligations on the coal industry in connection with wages and social service benefits that do not apply to the oil industry, a tax should be imposed on the oil producers to check this "unfair" competition. Another argument that has even less relevance is that used by the Opposition that the coal industry's problems are entirely due to the British Government's credit policies.

It has been suggested that the Six should have a coordinated energy policy. This is the view of M. Jean Monnet's Action Committee which, in a declaration published in November last, called for the coordination of international and national policies on production, imports and investments, by "next spring." But M. Monnet was thinking principally in terms of the Six. What of the newly formed European Free Trade Association? Within the Seven the prospects of coordinating energy policies are not bright because of the wide disparity in their resources.

Joint energy policies for the two groups, the Six and the Seven, look much more promising. Coordination is always easier if the needs and resources of the countries being coordinated are complementary. It is easier to link up three coal producers, three oil producers and one energy importer than seven coal producers. As it happens the main European reserves of natural gas are within the Six, and of hydro-electric power in the Seven. Some of the latter, notably Austria and Switzerland, are already large scale exporters of hydro-electric power. Another factor that may bring Six and Seven together is cooperation in nuclear policies through the European Nuclear Energy Agency (ENEA) set up by OEEC, and the European Organisation

for Nuclear Research (CERN). The recent difficulties over placing contracts under the United States-Euratom Agreement show that the six-nation grouping may not necessarily be the right size for coordinated nuclear energy programmes. A closer tie between the west European organisations concerned with nuclear energy is a distinct possibility in the next ten years. By which time, in the view of some experts, electricity from nuclear power stations will be competitive in price with that from conventional stations.

And the prospects for other fuels? Oil will certainly be increasingly important in the energy scale. Supplies outside Europe are plentiful and the entry of Saharan oil will lessen dependence on Middle East sources. The development of the oilfields of the Sahara will bring the coal-oil problem to a head in the next year or two. One reason is that these deposits will only be profitable if developed on a big scale. The quantities coming in will therefore be considerable. A second point is that the pipelines now under construction or projected in Europe bring fuel oil right into the heart of the industrial regions. One commentator remarked recently that there was a coal mine at the end of every oil pipeline. While that is not literally true it is near enough to show how uncomfortable the position of the coal industry is becoming, especially in Germany.

So far as coal is concerned the main problem is to organise an orderly retreat. The big need is to modernise the industry so that its productivity will rise in line with increases in the productivity of industry as a whole. At the present time the British coal industry's wages, and therefore costs, rise with increases in general industrial productivity. In other words the coal industry has arrived at a level of costs out of line with its productivity. The remedy is the closing of marginal pits, with the related problem of finding employment for displaced miners elsewhere. In Britain this process has gone fairly smoothly up to now. In round figures some 30 pits have been closed and over 9,000 of their 10,000 miners placed in jobs elsewhere. Recruiting for the industry has almost, stopped. But the change over from coal will necessarily be a slow process and a difficult one.

RETREAT FROM COAL

This retreat from coal is not a problem only in Britain. Last year it led to a prolonged quarrel within the ECSC over the need to close down marginal pits in Belgium. A solution has only been reached after the policies of the High Authority had been rejected by the Council of Ministers, which means in effect by the national governments. Now Belgium is for the present at any rate outside the Common Market for coal and the Belgian Government is allowed to licence imports from outside countries including the other ECSC members.

The adjustment in size of the coal industries of West Europe can be carried out in three ways. These are: (1) by the action of central planning authorities in fixing prices and production quotas; (2) through the test of efficiency as applied by the working of the price mechanism; and (3) by a mixture of both these methods. On the continent, especially within ECSC, the first method is most likely to be used. In Britain the basis of policy is the test of efficiency backed up by the Government directives. Here, however, it must be pointed out that the stopping of open-cast mining, the cheapest form of production at the present time, raises some doubts on the Government's determination to bring down coal costs. In one respect Britain has an advantage over the Six in not having to reconcile the warring claims of home producers of coal, oil and natural gas. But the working out of a fuel policy to meet the new situation at national, let alone international level, is an extremely difficult task. Forecasts are not the same thing at all as policies and the experience of the last few years has done nothing to strengthen confidence in either. It is to be hoped that the Robinson Report when it appears will underline the fundamental problems of deciding comparative costs for competing sources of energy, the difference between long and short term prospects and the complications introduced by party politics and by national and sectional interests. This is asking a lot of any Committee, especially an international one, but the need for guidance at this time is extremely urgent.

Why the French Enjoy their Railways

Like its bigger brother in Britain, the Société Nationale des Chemins de Fer Francais operates at a loss and has done so for years. Yet it is a highly progressive and dynamic organisation, managed by men of outstanding ability and utilising the most modern techniques. Its major advantage over British Railways lies in the near total destruction of its rolling stock during the war. This enabled a quick and effective transition to electric and diesel traction which now handle over half the total traffic. It also made possible a complete re-planning of the whole system, largely unhindered by either the existence of large quantities of half-written off but obsolete equipment or by too much tradition. These are important advantages possessed by SNCF over British Railways but largely accidental. Another, perhaps more telling in the long run, is the high degree of Government and popular support enjoyed by the SNCF and its employees. Everyone in France appears to like the "cheminot," the railwayman, despite innumerable strikes, and the Government of the day has invariably granted the funds and given the usual support required for an effective re-birth. The existence of this national sympathy and confidence is evidenced by the eagerness with which any capital issues are taken up by the investing public.

FINANCIAL RESULTS

The past few years have seen a steady development of traffic which has been more than offset by the twin curses of any railway administration: the inability to stem rising costs, particularly wages, and the socio-political obligation to run unprofitable services and to keep charges lagging behind. In these things the French are probably even more handicapped, and more subtly than the British.

In considering the financial results of any railway, allowance should be made for the fact that a revolution has taken place in the methods of handling passengers and freight on permanent way and that it has come later than the revolution in road haulage. Also, that rolling stock—particularly locomotives—represents a higher initial investment thereby inspiring a slower rate of change however desirable on technical grounds. There are signs however, that the optimum operating conditions on rail are being reached and may be universally reached within comparatively few years. The SNCF state that a return of 15 per cent on capital is being obtained on electrified lines: this is as good or better than obtainable in most industrial activities, including road haulage. Finally there is the factor concerning the relative economics of high density traffic on road and rail: the latter is infinitely controllable by means which will become largely automatic and there fore labour saving while road transport is subject to uncontrollable (in practice) fluctuations and nearly constant labour costs. Provided certain problems can be solved, such as the provision of service equal to that obtainable from the more flexible road transport, SNCF are confident that profits will replace deficits and probably rightly so.

TRAFFIC TRENDS

There has been a substantial increase in the amount of traffic handled by SNCF since the war although by no means proportional to the increase in French industrial activity. Only slightly more people travelled by rail in 1958 than in 1957 (552 million compared to 540 million) but in terms of passenger-kilometres there has been an increase of 50 per cent. Freight handled has risen from 133 million tonnes in 1938 to 212 million tonnes in 1958 and tonnes-kilometres almost exactly doubled from 26,500 million to 52,900 million. The average train load has increased by 17·4 per cent during the same period.

The analysis of freight traffic shows a major and continuous increase in the tonnage carried of metalliferous ores and metals, a large (compared with prewar) but not sustained increase in the handling of coal and other fuels. Together these product groups account for well over half the total tonnage carried, a proportion which has not varied apparently over the past 20 years. The principal loss of ground to road haulage is probably in foodstuffs and industrial materials, wherever the perishable or breakable character of the goods warrant the use of door to door transport without transhipment. Eggs, for example, are transported by rail far less than before the war; the proportion reaching Paris by road has increased from 31 per cent to 68 per cent. Butter, cheese, meat, livestock, and sea food, show a similar trend.

SNCF have attempted to provide a door-to-door service mainly by offering to carry lorries or trailers on railway wagons, a development which they describe as "a major new step in the technical coordination of rail and road." In this they are tending to follow American practice rather than British where the accent is on the provision of suitable containers to compete effectively with road transport. Two new organisations have been created to handle this new form of traffic and promote its use. The Société de l'Equipment des Grands Itineraires (SEGI) was formed in 1957 to undertake research, carry out wagon design and also lorry and tractor design, as well as to raise necessary funds. Another company, Société de Traction et d'Exploitation du Materiel Automobile (STEMA) was formed in 1958, which includes as members a majority of French road hauliers, is responsible for the economic operation of the new wagons built by SEGI and for the use of terminal facilities constructed by SNCF.

Actual results are encouraging though it is perhaps too early to draw conclusions. There is no question that this form of transport is highly competitive and excellent on routes where there is steady freight traffic over long distances, for example, between Paris and Lyon and between Paris and Bordeaux where the freight services were started. SNCF have been careful to state that the new method will not be available for freight "normally handled by rail" and have reserved the right to turn down any business in that category.

NEW WORKS

The major undertaking of recent years has been electrification of the Paris-Lille line, using AC 50 cycle supply. The work was completed at the end of 1958 and 1,559 kilometres of line have been electrified. In the publication *L'Année Ferroviaire, 1959* (Librarie Plou, Paris 1959) the whole project is discussed in an article by the director of the Nord region of the SNCF, M. Jean-Marie Goursat. He describes the conditions in which the scheme was executed, outlines the technical problems which had to be surmounted and indicates the returns which can be expected. It is excellently documented and an important contribution from an operator on the potential offered by electrification.

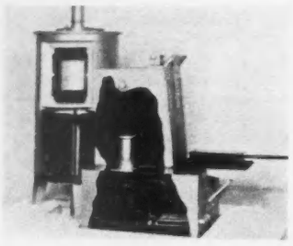
CLOSED QUENCH FURNACE

Vertical Model

A VERTICAL closed quench furnace of cylindrical form has been introduced for gas carburising and carbonitriding operations.

The furnace has a vertical cylindrical heating chamber that is closed at the top and has provision for the insertion of a charge through the base. Heating is electrical by means of Corrtherm elements or gas fired with radiant tubes. Baffles protect the charge from direct radiation.

It is claimed that the cylindrical shape will receive a greater charge for a smaller wall area. As a result, heat losses are reduced and a smaller amount of purging gas is required. The work, normally in a nickel-chrome basket, is moved into the purging vestibule of the furnace through an outer vertically rising door. A gas curtain prevents the entry of air. A large trolley is used to move the charge, and built into the trolley is a raising and lowering mechanism. After charging, the trolley is lowered and withdrawn.



The charge is removed from the chamber by lowering the bung and transferring to the quench elevator by the trolley. After it has been lowered into the quench tank the outer furnace door can be raised and a new charge inserted.

The purging vestibule and the space beneath the heating chamber are water cooled. The quench tank is fitted with preheaters, a water tube cooling system, and an agitator. Agitator, motor, and cooling system are mounted on a top plate removable for inspection and maintenance. The furnace can also be supplied with a hot oil tank for marquenching. *Electric Resistance Furnace Company Limited, Netherby, Queens Road, Weybridge, Surrey.*

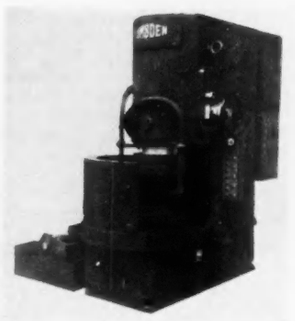
SURFACE GRINDER

Automatic Feed Control

LATEST addition to the Lumsden range of surface grinders is the 90ML machine that is fitted with automatic feed control and improved safety devices.

The new automatic feed control allows the amount of stock to be removed to be preset accurately. The amount plus an allowance for wheel wear is set on the trip dial, and the feed rate adjuster set to the required value from the ten feeds available. The trip dial then turns as the grinding wheel descends so that it always registers the amount of stock still to be removed. The feed is stopped when the dial reaches zero. A second dial, graduated in 0·001 in divisions, is provided for setting and adjusting the trip mechanism.

Also new on this machine is a safety device to guard against failure of the supply to the magnetic chuck. In the event of failure a relay starts the elevating motor for the grinding wheel spindle ram so that the wheel is brought clear of the work; all other motors are stopped. The residual magnetism



holds the work until the wheel is clear.

Other interlocks are provided, one of which requires the feed hand-wheel to be pulled outwards before the feed motor can be started to ensure that there is no risk of a blow from the hand-wheel spokes, and also that the "down" button is inoperative should this be pressed instead of "feed start." Another interlock requires the magnetic table to be energised before the spindle is started. *Alfred Herbert Limited, Coventry.*

HACKSAW BLADE

Graded Teeth

THE Aven Progressive Teeth hacksaw blade is designed to overcome the need for changing blades to obtain the correct tooth pitch for each particular material.

The blade is also designed to take advantage of the varying pressure normally exerted during hand sawing. Therefore the teeth are finer pitched at the start where the pressure applied is less, and become coarser towards the end. The range is from 29 teeth per inch increasing gradually to 18 per inch at the end.

As the stroke progresses and the operator applies more pressure, the coarsening pitch permits the removal of more metal. Another special claim is that as the pitch is right for the applied pressure at all times the blades are not subjected to shock or jarring, with a consequent reduction in breakages either of teeth or the blade itself. Blades can be supplied in either high speed or low tungsten steel. *Hacksaws Limited, Capel Street, Owlerton, Sheffield 6.*

POWER PACK

Transistorised Unit

THE LS353-H supply unit is intended for use where a compact stabilised power source is required.

The basic unit is a germanium junction rectifier circuit with a transistor voltage stabiliser and a reference potential device. It is a development of the Altron constant potential charger supplied for use with mercury-cadmium accumulators. The circuit provides a high degree of stabilisation against voltage fluctuations and a low ripple content. A preset control permits output voltage variation over a small range.

The nominal output potential is 6·3V and the stability against mains variation of $\pm$ 10V is 25 mV. The full load ripple is less than 3 mV rms. The unit will operate from mains supplies of 190 to 260V and the chassis measures 4 in by $10\frac{1}{2}$ in by $6\frac{5}{16}$ in. The weight of the unit is $7\frac{1}{2}$ lb.

The pack can also be supplied complete in a case. *Allied Electronics Limited, 28 Upper Richmond Road, Putney, London, SW15.*

HOBBING PRESS

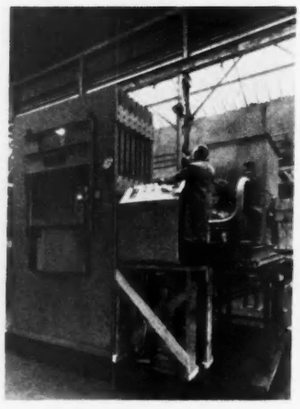
For Mould Forming

A 5,000 ton hydraulically operated hobbing press has recently been completed.

The hobbing process for forming moulds consists of slowly forcing a master male die into a blank of normalised steel until the required depth is reached. The mould is then finished by machining, heat treatment and a final grinding or polishing operation. The speed of penetration must be slow to avoid splitting the blank. This press will operate down to 0·01 in per minute, controlled by pump selection and adjustment of the control valve. The press can also be used for hot forging or cold flow forging at reduced loading and higher ram speeds.

The new press will drive at 14 in per minute for loads up to 1,500 tons and speeds of 0·1 to 0·4 in per minute at 5,000 tons by using different size pumps (from 1 h.p. to 4 h.p.). Use of the flow control valve gives the final adjustment down to 0·01 in per minute.

The press weighs 73 tons. The frame



is made of eight $3\frac{1}{2}$ in steel plates keyed together, and providing a work table 40 in square. There is 32 in of daylight. The single upstroking ram has a diameter of 48 in and a stroke of 8 in. Two 60 h.p. motors drive the main pumps. *Hydraulic Engineering Company Limited, Chester.*

ENGINEER'S LEVEL

With Cross and Plumb Vials

A NEW engineer's precision level incorporating both cross and plumb vials has recently been introduced.

The main vial is ground and graduated in one-tenth inch divisions and is housed in a chromium plated brass tube. This tube is surrounded by a protecting sleeve that can be turned to cover the vial when the level is not in use. Clear liquid, which will not discolour with time, is used in all three vials.

The base of the instrument is made of high grade cast iron finished in black crackle enamel. It is accurately machined and is provided with a concave groove for use on cylindrical work, on shafting, etc.

When the level is used on round work, it is possible to check any tendency to cant by using the cross vial.

Model 305/12, now available, has a 12 in base and is supplied packed in a wooden box. Other models extending the size range are to be produced. *Moore and Wright (Sheffield) Limited, Handsworth Road, Sheffield 13.*

RADIANT HEATER

Adjustable Coverage

TWIN-Zone radiant heaters have been developed to give either concentrated or widespread warmth from one unit.

The variation in heat intensity is effected simply by raising or lowering an aluminium reflector within the body of the heater, the distance of the reflector from the elements governing the width of the beam of radiant heat.

Two sizes are made, rated for $1\frac{1}{2}$ and 3 kW. The frames are sheet steel and the reflectors aluminium. Wire guards can be fitted. A single 3 kW heater adjusted to the narrow beam and suspended horizontally at a height of 12 ft above floor level will give an intensity of 35 Btu per sq. ft per hour at shoulder height. Adjusted to the broad beam and hung in groups at 14 ft height with 16 to 18 ft between rows and 10 ft between centres, a uniform intensity of about 30 Btu per sq. ft per hour will be obtained at shoulder height. *General Electric Company Limited, Magnet House, Kingsway, London, WC2.*

ULTRASONIC CLEANER

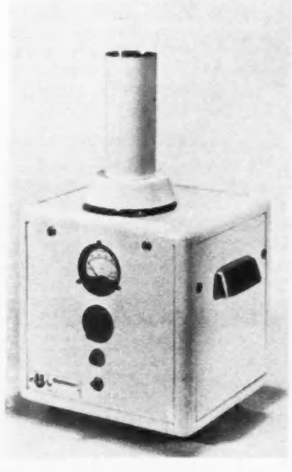
Laboratory Unit

THE Rapiclean is an ultrasonic cleaner designed primarily for laboratory use and small scale production.

The unit has a beaker of 100 cc capacity mounted on top for convenience and to reduce the bench space required. The operating frequency is 13 kc/s at which the energy conversion is said to be very efficient. The principles involved in the operation are magneto-strictive transduction and cavitation. A high rate of cleaning is claimed.

As only 18/8/3 stainless steel is in contact with the cleaning medium, there is no danger of contamination or corrosion. The simplicity of design and the clean outlines also make for easy maintainence.

The controls have been reduced to a minimum: there is only one mains switch, one indicator light, one meter and one tuning knob. It is a complete unit and runs off standard mains supplies. Special claims are low price; high power output; robustness; and the fact that operation is virtually unaffected



by temperature. Work can be carried out satisfactorily at above 100° C. *Ultrasonics Limited, Westgate, Otley, Yorkshire.*

SIGNAL GENERATOR

Higher Frequencies

MODEL 61A signal generator is designed for the servicing of AM and FM high frequency receivers, and the inter-carrier stages of television sets.

Used in conjunction with an oscilloscope, the instrument provides facilities for sweep alignment. It includes a crystal calibrator. The AM section covers the range from 4 to 120 Mc/s in five bands, all on fundamentals. The FM and sweep section covers from 4 to 12 Mc/s and from 70 to 120 Mc/s in three bands, also on fundamentals. The calibration accuracies of the AM and FM generators are 1 per cent and 2 per cent respectively. The AM generator may be used as a marker during sweep alignment. A variable phasing network is incorporated and retracing blanking is provided.

Deviation on FM is variable up to 100 kc/s from the mean carrier frequency at a modulation rate of 400 c/s. The sweep covers a total bandwidth of 1 Mc/s at power line frequency. A crystal calibrator circuit with switch selection of any one of three internally mounted crystals is incorporated. Crystals can be supplied in the frequency range from 1 to 11 Mc/s.

A five section attenuator with a non-inductive potentiometer ensures accurate attenuation over the whole frequency range.

Radio-frequency leakage has been reduced to a minimum by the careful shielding of the attenuator and oscillator sections. The Taylor edgewise type meter is used. An added facility for servicing audio stages is the inclusion of a variable level 400 c/s signal. *Taylor Electrical Instruments Limited, Slough, Bucks.*

BOWL SCREENS

Changeable Mesh

A RANGE of bowl type vibratory screens has been developed in which the screen can be changed by the operator.

Mesh of the required size is simply cut from a roll and clamped in position over the bowl using a loose clamping ring that bears against a second ring welded to the frame. The use of an expensive beechwood hoop and screen assembly is thus avoided and screens can be discarded when contaminated or damaged, at only small cost.

The bowls were developed largely for use in the paint industry and are made in two standard sizes, though others can be obtained to order. The smaller model is 18 in diameter and the larger measures 24 in.

The weight of the smaller is about 1 cwt. The throughput depends of course on the mesh used but an average figure for paint using the 18 in model is 200 gallons per hour. The vibratory unit is powered by a squirrel cage motor running from a three phase supply and the whole equipment is designed for long life. *Sinex Engineering Company Limited, North Feltham Trading Estate, Feltham, Middlesex.*

COLLECTOR TROLLEY

200 A Capacity

A LARGER-capacity collector trolley is now available for use with the Fuller electric power supply track for travelling cranes.

The new trolley has a rating of 200A per collector on each of four insulated trolley busbars. Enlarged bars for this application have a normal rating capacity of up to 300A according to the contact area.

On the trolley, separate connections from the collector are taken to twin terminal boxes. Each of these boxes serves one pair of collectors on one side of the power track. By this means it is possible to increase the capacity per line to approximately 400A by parallel pairs of collectors for d.c. or for single phase two wire supplies.

This new equipment augments the earlier versions of the fully guarded trolley supply system (which had a maximum rating of 120A) and covers the demands of the larger cranes now being installed. *Fuller Electric Limited, Fulbourne Road, London, E17.*

STRADDLE CARRIER

Loads of 20,000 lb

CLAIMS for a new medium capacity straddle carrier are improved manoeuvrability and performance.

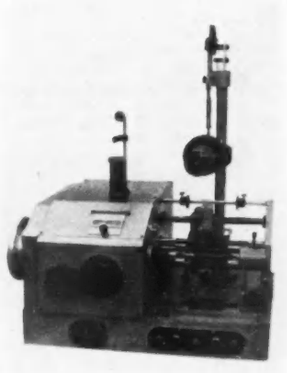
The M200E has a load capacity of 20,000 lb and shares many components with the larger 30,000 lb model, including power plant and hoist system. The turning radius is smaller however, and road speeds up to 52 m.p.h. are possible. The carrier has four wheel power steering, and dual-coil spring independent suspension. Power brakes are fitted as standard.

Power is supplied by a 164 h.p. V8 engine driving through a heavy duty gear train. A four speed full reversing synchromesh transmission is fitted. The hoist system is designed for fast pick-up and the load shoes swing under hydraulic power to give fast positive opening and closing.

Optional features on the straddle carrier include an LP-gas fuel system, and a Perkins P6V diesel engine. *Hyster Company, PO Box 847, Danville, Illinois, USA.*

COIL WINDER

Down to 50 swg Wire



A NEW bench type coil winding machine is now available which will handle wire sizes from 30 to 50 s.w.g.

The machine is fitted with a five figure reset revolution counter and can be designed for any maximum speed up to 4,000 r.p.m. The rate of acceleration from zero to maximum speed is determined by means of a plastic hand-wheel on the front of the machine which operates a potentiometer that in turn controls the Warner electric clutch in the drive from the motor.

Coils can be wound up to 5 in diameter and up to 3 in length. The reel carrier spindle is suitable for reels up to 6 in diameter but for the winding of fine gauges (from 47 to 50 s.w.g.) a small " over end feed " is also supplied.

The traversing mechanism incorporates two Warner electric brakes coupled to two worm wheels in constant mesh with two lead screws. The traverse is set by means of adjustable stops which actuate microswitches that energise and de-energise the brakes and so give positive and instantaneous reversal of direction.

The wire spacing, and therefore the number of turns per inch, is set by means of a hand-wheel moving against a scale calibrated in s.w.g. and inch decimals. *Westool Limited, St. Helen's, Auckland, Co. Durham.*

INDUCTION MOTOR

Using Class E Insulation

SQUIRREL cage totally enclosed fan cooled induction motors with class E insulation have been added to the AEI range.

These machines are directly interchangeable—both rating for rating and size for size—with the existing ventilated series type KN-C. The new machines have ribbed frames and end shields and comply electrically with BS2613. The permitted temperature rise is 65° C above ambient.

The use of the improved insulation makes it possible to offer a motor of smaller dimensions at a lower price than the earlier class A insulated model, in which the temperature rise was limited to 55° C.

Type KN-D motors are immediately available in sizes ranging up to 7½ h.p., and the range is to be extended soon to cover powers up to 40 h.p. at speeds of 1,500 r.p.m. *Associated Electrical Industries Limited, Motor and Control Gear Division, Crown House, Aldwych, London, WC2.*

VARIABLE TRANSFORMER

Separate Windings

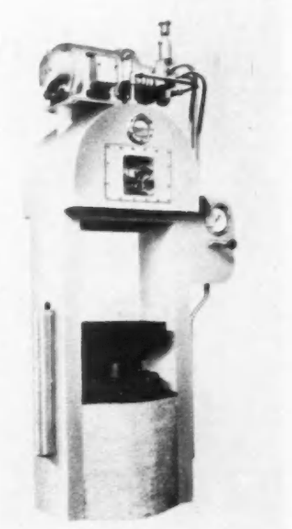
A NEW bench or panel mounting variable transformer rated for 450VA has the primary and secondary windings separate.

The circuit has two widely overlapping output ranges, from 0 to 245V and from 0 to 300V, with an input of 220V. In the lower range only part of the primary winding is used but on switching to the higher range the whole winding is brought into operation.

Two pairs of output sockets are provided for the bench model which measures 9½ in by 8¼ in wide. The nominal secondary output current is 1·5A and the no-load losses are 15W maximum at a primary voltage of 180V, and 7·5W maximum at 240V primary. The specified ratings apply when the ambient temperature does not exceed 40° C. The bench model weighs 20 lb and the panel mounting version, which is supplied without case, 17 lb. *Research and Control Instruments Limited, Instrument House, 207 King's Cross Road, London, WC1.*

ARCH PRESS

Up to 1,000 Ton Capacity



TWO new arch presses have been introduced into the Prestige range.

They are for cold flow forging, hot and cold forming and general press work over a wide range of component size. The action is upstroke with the platen hydraulically operated. The pump is driven by an a.c. motor through direct couplings. Included in the system is a calibrated relief valve enabling pressures and loads to be preset accurately. Control can be by fixed or pendant push button, foot lever or foot bar. The standard model is provided with a hand lever.

The main frame is of arch construction designed to withstand the maximum load with the minimum deflection. Two internal machined slides engage with the platen to maintain alignment. Both platen and head have machined faces and can be provided with T-slots. The 500 ton press requires a floor space of 33 in by 24 in and the 1,000 ton model needs 54 in by 36 in. *William Jones Limited, 1 Fitzroy Square, London, W1.*

SHEET GRADER

Thickness and Surface Finish

METAL sheets are graded into prime and reject by a new automatic machine which is designed to be installed in the cropping line.

Plates from a shear line are passed into the machine, the control panel of which is linked with the shears. The rejection of sheets is governed by a thickness tolerance of ± 0·0005 in, by detection of perforations and by the surface condition.

An electric signal operates the rejection gate and diverts the faulty sheet on to a lower conveyor which takes it to the reject stacking line.

After passing the reject gate a mechanism can present the sheets singly for inspection. Prime sheets are carried along to the second stacker and are counted on to a pallet. When the preset number have arrived the pallet is lowered on to the conveyor and an empty pallet is brought forward into position. Sheets that arrive during the exchange are caught on extending prongs that retract when the empty pallet is ready. Photo-electric cells adjust the pallet as the

sheets arrive so that the top one is always at the same height. Hand wheels at the sides and rear allow adjustment for sheet size.

A warning bell rings when a full pallet has run down the conveyor. Audible warning is also given as soon as the supply of empty pallets is exhausted.

The machine is capable of handling 175 sheets per minute measuring from 18 in by 24 in to 44 in by 38 in. Maximum pallet load is 9,000 lb. The conveyor belts can work at any speed from 100 to 1,200 ft per minute. Steel, tinned or aluminium sheets can all be handled. *Bren Manufacturing Company, Team Valley, Gateshead 11.*

INDUSTRIAL MOTOR

Totally Enclosed Fan Cooled

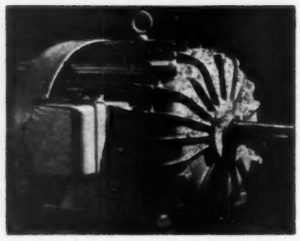
A RANGE of totally enclosed fan cooled electric motors with insulation to class E standard has been added to the Crompton types.

The use of class E insulation has allowed a reduction in overall size so that the output power for the same frame size is double that of earlier totally enclosed models. Rating for rating the motors are smaller and lighter and are about 9½ per cent cheaper than the ones superseded.

Electrically the series 5TEFC motors conform to BS2613; dimensionally they conform to a new draft specification and their fixing dimensions are the same as the series 5 ventilated motors. Both for power and size they are directly interchangeable.

In addition, all these motors can now be supplied to NEMA specifications for fixing dimensions and can therefore be exchanged in American machines.

It is particularly claimed that cooling is extremely efficient and it has proved possible in the smaller motors—up to



frame size 184—to dispense with longitudinal cooling fins on the outside of the motor carcase.

A high rate of heat transfer from the interior to the exterior has been obtained by careful design; for example, by the interference fit of the stator stamping packs in the housings.

The motors are to be made in a range of standard sizes from 1 to 40 h.p. running at 1,400 r.p.m. The standard model is suitable for most industrial applications but special rotors for high torque or for flywheel drive will also be available from the makers. *Crompton Parkinson Limited, Crompton House, Aldwych, London, WC2.*

VIBRATION METER

Direct Reading

A NEW Philips direct-reading vibration meter includes a wide measuring range and direct indication in vibration amplitude.

The unit is fed from a transistor amplifier supplied from a miniature built-in battery. There is an additional input for a phase indicator and an output jack for an oscilloscope or recorder. The battery is rechargeable.

The instrument is supplied complete with battery and mains cable in a carrying case, in which there is also room for accessories such as a vibration pick-up. A special feature claimed for the instrument is its light weight and small size. The meter itself measures 220 mm (8¾ in) by 130 mm by 100 mm and weighs 2·5 kg (5½ lb). Complete in case the dimensions are 250 mm by 240 mm by 250 mm and the weight inclusive of cable is 4·3 kg. Accessories available include the absolute vibration pick-up mentioned. *Research and Control Instruments Limited, Instrument House, 207 King's Road, London, WC1.*

TIME CODE GENERATOR

For Test Data

A NEW time code generator which produces accurate timing signals during the recording of test data on magnetic tape is being made by the Computer-Measurements Company.

On playback of the tape, the time signals can be used to reconstruct the time sequence of events for either visual analysis or for data processing equipment. The model 1021 generator consists of a crystal controlled oscillator and seven decades of frequency division. It produces eight separate timing signals between 100,000 and 0·01 c/s. Each signal is coded by a different width. The use of a variable pulse width to code each timing signal permits mixing of signals to identify elapsed time.

The generator uses electronic counting and timing devices including a time interval meter. Short term stability is within one part in 10^6. The generator can be controlled from external sources to synchronise the start time. *Ad. Auriema, Inc., 85 Broad Street, New York 4, NY, USA.*

WORK TABLE

Adjustable for Height

THE work table illustrated is adjustable for both height and angle of surface.

It was designed originally for use with the smaller induction heaters in the Delapena range, models E4, E6/9 and E3/4. The table is simple in design and can easily be attached or removed.

The working platform is of heavy gauge aluminium attached by screws to a welded steel frame. It is supported on two horizontal arms welded to vertical tubes which slide in outer tubes attached to the case of the machine. The table is locked at the chosen height by wing nuts. When a slanting surface is required it can be obtained by unequal adjustment of the tubes; the platform attachments have been made slotted for the purpose.

The whole table unit is attached to the heater by four studs and nuts. If it is desired to remove the platform only, it can be slid off the arms by releasing the stops and the arms can then be folded flat against the set. *Delapena and Son Limited, Zona Works, Tewkesbury Road, Cheltenham, Glos.*

COUNTER BATCHER

Up to 1,000 per Lot

A THREE decade counter batcher for general use has been developed. It will count and batch any quantity between 0 and 1,000.

The unit provides high speed counting operated from a photocell, contacts or switches, and provides output facilities of either changeover contacts or a d.c. pulse voltage of variable amplitude and duration. A voltage pulse can also be used as the input source, the maximum sensitivity being obtained with a square wave for which the minimum amplitude is 2 V. However a regular a.c. waveform can be used if the amplitude is sufficient. When used for batching, provision is made for manual, automatic and external resetting.

The unit is designed to fit a standard 19 in rack and incorporates a stabilised power supply. The rate of counting is up to 7,000 pulses per second and the batching rate 5 per second. On automatic operation the batching reset time is less than 5 milliseconds. *F. C. Robinson and Partners Limited, Councillor Lane, Cheadle, Cheshire.*

VIBRATING DRIVE MOTOR

Adjustable Output

AN electric motor for supplying a vibrating drive is now being made in this country.

The unit is completely self-contained and eliminates all the mechanical parts associated with an eccentric shaft arrangement. The vibration is generated by out-of-balance weights fitted at both ends of the motor, which can be easily adjusted by bolts to give the required output. The whole unit is robust and the motor is totally enclosed, dust proof and weather proof. The shaft is of high tensile steel. The motor must be mounted on a resilient base.

When running at 1,500 r.p.m. synchronous speed, the maximum output is 7,500 lb centrifugal force rising to 10,000 lb at 3,000 r.p.m. The motor is operated from a 3 phase 50 cycle supply at 110 to 650 V. Insulation is to class E. The range of standard models covers powers from fractional to 10 h.p. with a corresponding variation in force available. *Grantham Electrical Engineering Company Limited, 6 Wharf Road, Grantham, Lincs.*

HYDRAULIC MANDREL

Big Size Range

THE Hydramandrel is an expanding mandrel that offers a wide diameter range for each size. There is as much as 2 in adjustment in one model.

The mandrel is designed to run between centres for external grinding work. The model illustrated has a range from 2¼ in diameter to 3 in diameter and is 14½ in long. The body length can be made to suit requirements. At one end is a knurled actuating nut which when turned forces plungers into the main body. The resulting increase in hydraulic pressure forces out the gripping plungers arranged at intervals to bear evenly on the workpiece.

Special claims are that very thin sections are held without distortion, concentricity is accurate, and the ends of the workpiece stand clear so that they can be machined at the same setting. Tapered or stepped bores can be gripped as securely as cylindrical ones. The mandrels are made in all sizes from 1¼ in diameter upwards. *Larrad (Hydrajaws) Limited, 44 Leigh Street, Coventry.*

Hydrogen Metamorphosis

Hydrogen keeps reappearing in various guises in the most unexpected places: in reactor engineering, cosmology, thermonuclear work—or as an additive to a well known Scottish beverage. Potentially hydrogen is the most effective moderator, and it has excellent heat transfer properties. But water, the most common form even in reactor engineering, has an uncomfortably high vapour pressure which limit its use either as moderator or coolant. Other forms of hydrogen have been tried, for various purposes and with varying degrees of success.

Liquid Hydrogen as a Moderator

As a special correspondent to ENGINEERING, Dr. F. J. Webb of Harwell writes about low temperature moderators being investigated at the Atomic Energy Research Establishment:

For many experiments a beam of much slower neutrons is required than obtainable from a room temperature moderator. If neutrons reach thermal equilibrium with a moderator at 50 to 100° C, the most probable velocity in the resulting Maxwellian distribution will be about 2,500 metres per second. The number of slower neutrons—in the order of 1,000 metres per second—available from such an energy spectrum is limited and hence experimentation in that energy range is inefficient. By bringing the neutrons into thermal equilibrium with a moderator at a lower temperature, the flux of neutrons in the desired energy range can be greatly enhanced.

Only a small volume of moderator can be kept cool inside a reactor, but at Harwell we have shown that liquid hydrogen is a very efficient moderator and that the flux of slow neutrons can be increased considerably in the vicinity of the low temperature moderator. The measured increase in the flux of neutrons of various velocities in a beam scattered from a volume of 250 cc of liquid hydrogen at the centre of a reactor, compared with a beam from a room temperature moderator, is shown below.

Neutron velocity (m per sec)	800	700	600	500	400	300
Factor of increase	7	12	17	20	22	28

Since December, 1956, we have operated such an apparatus in the reactor BEPO at Harwell to provide a beam of slow neutrons. Liquid hydrogen is circulated at a rate of 3 litres per hour through a moderator chamber at the centre of the reactor from a 70 litre storage vessel. The whole of the hydrogen circuit inside the reactor is enclosed in a thick-walled vacuum case, strong enough to withstand the force of any possible explosion; this precaution removes any possibility of damage to the reactor. We have used this apparatus to investigate the efficiency of various low temperature moderators. Since the scattering cross section for slow neutrons of ortho-hydrogen is some forty times as large as that of para-hydrogen, one might expect ortho-hydrogen to be a more efficient moderator. However, experiments with the ortho-hydrogen concentrations varying from 75 per cent down to 2 per cent indicated no change of moderation. Liquid hydrogen deuteride at 20° K also gave identical moderation.

A similar liquid hydrogen loop is being built to maintain a small volume of liquid hydrogen inside the high-flux reactor DIDO at Harwell. The necessary cooling is provided by a very simple closed-circuit Joule-Thomson hydrogen liquefier. By using a Corblin diaphragm compressor to avoid contamination and recirculating the same gas continually, the need for cleaning the gas is minimised. The heat exchangers of the liquefier are of very simple design: the liquid nitrogen bath boils at atmospheric pressure, and the "expansion valve" is a fixed constriction made from a length of capillary tubing. The whole of the gas-liquid mixture from the expansion valve passes into the reactor and back through the heat exchangers of the liquefier. The liquefier is in fact used as a refrigerator: the total heat of the liquefied hydrogen, not merely its latent heat, is employed. The plant is designed to run continuously to maintain a liquid hydrogen moderator inside the reactor and to enable experiments of long duration to be performed with the intense beam of slow neutrons it provides.

Hydrogen Cooled Reactors

Except for certain dangerous properties, hydrogen is the best gaseous reactor coolant if only nuclear, chemical, and heat transfer properties are considered. If hydrogen were substituted for carbon dioxide in a hypothetical reactor, the heat output could be theoretically increased by a factor of 3·5, and the power consumed in the blowers could be reduced to a quarter under certain operating conditions. The capital costs of carbon dioxide and hydrogen cooled reactors would not differ much; savings due to increased heat output would be wiped out by the stringent safety requirements of a hydrogen plant. Mass transfer of carbon is not a serious hazard, although the equilibrium concentration of methane is high. In a test loop of BEPO it was found that polymerisation of hydrocarbons occurred only in small quantities. Chemical reaction with metallic uranium proscribes its use, but oxides or carbides are compatible to 1,500° C.

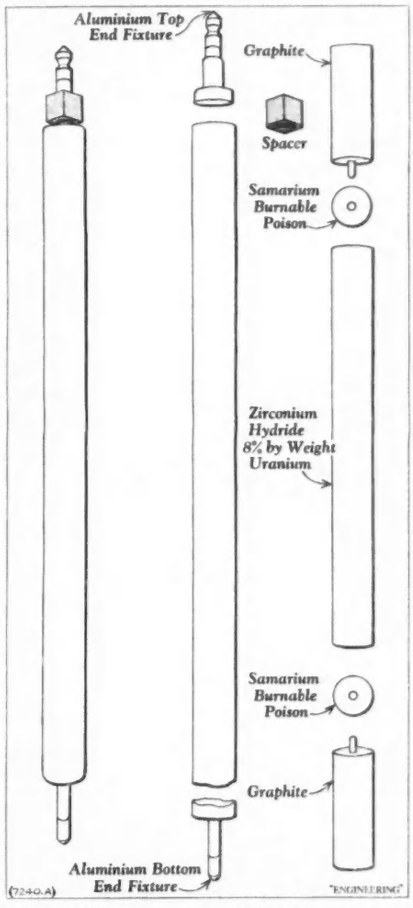


Fig. 1 Solid homogeneous fuel-moderator assemblies for the research reactor Triga.

Metallurgical effects of hydrogen cooling are physical embrittlement of steel caused by hydrogen diffusion into the grain boundaries. The process would be aggravated by neutron irradiation. To prevent embrittlement, the reactor vessel would have to be cooled at a very slow rate—less than 30° C per hour—following shut down. Fuel canning materials which are compatible with hydrogen include aluminium, magnesium, stainless steel and beryllium. For high-temperature applications only stainless steel and beryllium come into consideration. Austenitic stainless steel does not suffer from embrittlement if free from inclusions; not enough is known of beryllium to assess compatibility under irradiation. Hydrogen coolant could only be used with slight enrichment of the fuel; the capture cross-section is 120 times higher than for carbon dioxide. Coolant loss would result in a decrease in reactivity.

Objections to Hydrogen Cooling

Objections to hydrogen cooling arise from difficulties with storage and handling, and the explosion hazards associated with leakage into or out of the system. Leakage outward can be dispersed to safe levels of hydrogen concentration by ventilation; but the purity inside the gas circuit must be maintained in excess of 95 per cent in all places and at all times. The purity requirements become more stringent as the reactor temperature is increased to prevent undesirable chemical reactions. The ability to guarantee at all times the required high purity is a necessary condition of hydrogen cooling, without which the considerable economies of the system cannot be realised. ("The Use of Hydrogen as a Reactor Coolant," by D. Bradley, presented to the Institute of Chemical Engineers.)

Hydrogen Solidified

Among solid moderators zirconium hydride is unique. The neutron physics of the material is such that, in the words of Atomics International engineers, "there is a definite probability of upgrading the neutron energy as a result of scattering processes." The outcome is a hardening of the energy spectrum or, expressed in other terms, an unusually high neutron temperature. Some interesting consequences follow from the neutron physics of zirconium hydride.

Atomics International found that the use of zirconium hydride in a heterogenous organic cooled reactor would permit a very flat power distribution through a fuel element cell, and hence a higher average fuel temperature. ("Economic Evaluation of Several Organic Cooled Reactor Concepts," by J. Brunings *et al.*) Parasitic losses to absorbers inside the reactor are less than with other moderators as a result of the hardening of the spectrum. On the one hand good neutron economy results, but on the other the worth of control-rod materials is reduced. Either more poisoning material has to be accommodated inside the reactor, or else new absorbing media with very high epithermal resonances must be found.

General Dynamics had also investigated the properties of zirconium hydride moderated heterogeneous reactors in connection with the marine gas-cooled reactor programme. It was found that plutonium fission made a greater contribution to the thermal power output than with any other moderator, even though the zirconium hydride reactor has a low initial conversion ratio and a low plutonium production rate. The explanation is that the high neutron temperature coupled with a neutron spectrum tending towards epithermal results in a high average ratio of fission cross-section of plutonium to uranium 235. In a reactor using fuel enriched 5·75 per cent, the contribution of plutonium fission to the reactor's thermal power was 13·5 per cent. ("The Marine Gas-cooled Reactor Program," by S. A. Bernsen *et al.*, Atomic Review, 18 Sept.'59.)

Zirconium Hydride in Triga

The principal nuclear application of zirconium hydride so far has been in the popular research and training reactor TRIGA marketed in considerable numbers by General Atomics, a division of the General Dynamics Corporation. The reactor is unique in that although the fuel is contained in cylindrical cans that resemble fuel elements (Fig. 1), the reactor is in fact homogeneous and the elements are filled with a mixture of 8 per cent by weight of enriched uranium and zirconium hydride. Approximately 2 kg of uranium 235 are required for criticality with a 20 per cent enriched fuel and aluminium cladding. The unusual arrangement was adopted by General Atomics in order to simplify the control of a reactor designed for low cost. Although control rods are provided in commercial version of the reactor, the safety is inherent in the core and a prompt negative temperature coefficient results from two factors. The temperature coefficient is negative because a rise in moderator temperature results in increased neutron escape from the fuel-moderator elements, and also in a doppler-broadening of the uranium 238 resonance peaks. With a light moderator such as hydrogen, this effect is more pronounced than with heavier elements. But in a non-homogeneous reactor a change in power level is not promptly followed by a temperature rise in the moderator, and hence safety is not inherent in the design: a fuel element meltdown may occur after a sudden power excursion before the moderator has time to "catch up." In TRIGA, the zirconium hydride—in essence a solid form of hydrogenous moderator—is mixed intimately with the fuel and the negative temperature coefficient comes into operation almost simultaneously with any change in the fuel's fission rate. Thus without the use of elaborate control systems the reactor can be operated at the design power of 10 to 30 kW, and short bursts up to 100 kW are permissible in normal use. During prototype testing, the self-regulating characteristic of the design was tested at power levels above 200 kW

with satisfactory results. Fig. 2 shows a commercial version of the reactor.

Organic Make-up Reduced

Even though the success of TRIGA proves the usefulness of zirconium hydride at low temperatures, very little is known to date about the structural and physical properties of the material at higher temperatures. The principal non-nuclear application is in the production of a cellular form of aluminium in which zirconium hydride mixed into aluminium is used as a hydrogen source to produce bubbles in the parent metal. But as a reactor material much is still to be learned. In a study for a 300 MW(e) zirconium hydride moderated organic-liquid cooled station, Atomics International found that the moderator charges would be about 0·3 mills per kWh compared with 0·18 for graphite and 0·02 for organic liquid moderator. But the reduction in organic liquid make-up through the use of a non-perishable moderator more than compensates for the increased inventory charges. Unfortunately, the estimate of zirconium hydride cost suffers from a number of uncertainties which render the conclusions unreliable. Owing to the large number of loose ends and lack of any working prototype, the zirconium hydride power reactor concept is not being developed by Atomics International beyond the design study stage at present.

Notes and News

Lame Dragon

When Project DRAGON was transferred from the UKAEA to the sponsorship of OEEC, some observers expressed their regret over the change. The patriots thought it a pity that one of the most promising reactor projects in the arsenal of the UKAEA should be internationalised, particularly since the ground work for the high-temperature gas-cooled reactor had been laid in this country during the development of Calder Hall. Others, less patriotically inclined, simply expressed their doubt about the ability of a heterogeneous organisation such as OEEC to proceed with a unity of purpose. It may never be possible to prove or disprove the critics' arguments, but the inevitable delay caused by the change in organisation can now be estimated. An eminent metallurgist in close contact with the project is of the opinion that at least six months of working time have been lost so far as a consequence of reorganisation—and the counter is still ticking. Collective decision-making is widespread and is particularly troublesome in view of the many languages employed by the members. There are now over 50 scientists and engineers employed on the project who may come from 12 different countries. There is no reason why a group of mixed nationalities should lack efficiency; ample proof of international collaboration can be found at CERN or at many other joint undertakings. The difference at Winfrith Heath is that the project was well under way by the time the transfer occurred: learning to walk for a second time is a painful process. The delay is a direct consequence of reorganising and restaffing a project long after its start.

Gas-Cooling an Organic Moderated Reactor

To combine high thermal efficiency with a low cost compact core, a correspondent in the December, 1959, issue of *Nucleonics* suggests a gas-cooled organic-moderated reactor. A gaseous coolant may serve as the working fluid of a power cycle of good efficiency, but a graphite moderated core is too bulky, and water moderated cores lead to insulation problems between coolant and moderator. As the operating temperature of organic liquids is much higher than that of water, the insulation problems would be greatly reduced. With a core pressure of 40 to 60 lb per sq. in. boiling of Santowax R could be suppressed at 570° F (299° C). Further, the non-corrosive nature of organic moderators would permit the use of ferritic steels in the core vessel and coolant pressure tubes. The chief disadvantage of the organic moderator is decomposition and formation of higher polymers under irradiation. The make-up requirement is around 40 lb per MWD for an organic moderated and cooled reactor. But if the organic liquid is not required to serve as primary coolant, a much higher concentration of heavy polymer can be tolerated in the moderator without seriously affecting the performance of the core. The author of the letter, Mr. G. B. Melese, of Columbia University, estimates that a 5 ft diameter right cylindrical core with uranium oxide fuel enriched 2 per cent could produce 15 MW(e) if a power cycle of 33 per cent net efficiency is used. The coolant gas at 1,000 lb per sq. in would operate between 515° and 880° F (268° and 471° C), with a maximum fuel surface temperature of 1,300° F (704° C). A different fuel with higher enrichment would be required to obtain 1,300° F coolant outlet temperature, the point where an efficient gas-turbine cycle could be applied.

Acts of God and Active Fuel Liability

From 1 April, 1960, all insurance policies relating to property damage or third party liability will be amended to exclude, in addition to acts of God, damage by nuclear radiation and radioactive contamination arising from nuclear fuels or their wastes. The clause does not exclude coverage for damage by radiation emanating from other sources such as X-ray equipment, commercial radioisotopes or particle accelerators. The affected policies will include land, home, factory and motor insurance, but life, pension, personal accident or sickness, and policies covering the liabilities of employers to employees for personal injuries will remain unaffected. The position of marine insurance is at present under review. The change in insurance coverage, announced by the British Insurance Association and Lloyd's, arises from the Nuclear Installations (Licensing and Insurance) Act, 1959, which compels operators of nuclear installations to compensate for any damage arising out of the release of radioactivity from installations under their control. Special facilities have been made available for the purpose through the British Insurance (Atomic Energy) Committee, obviating the need for private insurance against radioactive damage. The committee was set up in 1956 in order to mobilise the resources of the whole British insurance market in view of the magnitude of the potential hazard of radioactivity. Coverage through the facilities of the committee does not extend to damage by radioactive fallout originating from nuclear explosions.

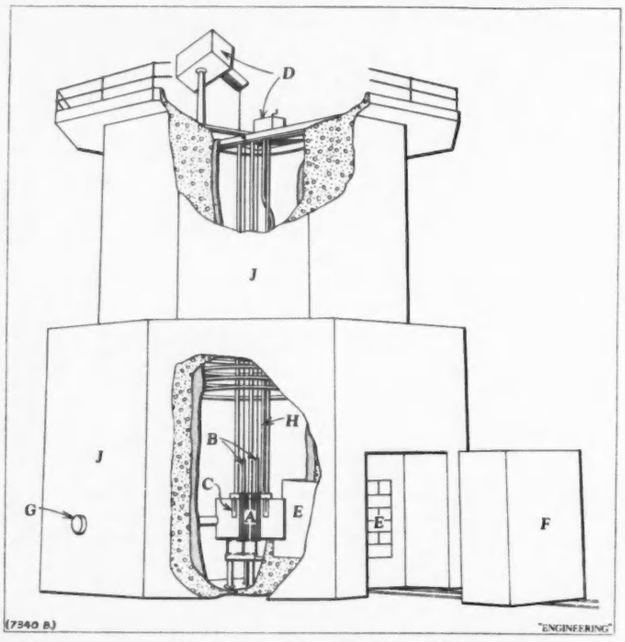


Fig. 2 A prompt negative temperature coefficient controls Triga without elaborate instrumentation.

A Core
B Control rods
C Rotary irradiation rack
D Rotary rack hoist and drive
E Thermal column
F Thermal column plug door
G Beam tubes
H Pneumatic transfer tube
J Shielding

Frequency of Accident's Affecting Ship's Reactors

It may be assumed that commercial carriers will install nuclear propulsion machinery only in the largest ships of their fleet for a long time to come. The effects of seagoing reactors on marine safety must be analysed in terms of the shipping casualties in the class of vessels with displacement exceeding 20,000 tons gross, requiring a propulsion plant in the range of 20,000 s.h.p. Ships of this size have only appeared in significant numbers since 1951, when tankers and ore carriers of unprecedented size were coming into service alongside the existing large passenger ships. In 1958 the number of ships exceeding 20,000 tons displacement was over 400, an increase by a factor of eight in seven years. In that period three passenger ships and two tankers became total losses, and 29 accidents resulting in partial losses could have caused damage to a reactor installed in the vessel. Although the number of accidents available for analysis is too small for statistical accuracy, it is probable that if the world total of nuclear powered ships reached about 45, an accident affecting the reactor compartment might be expected every year. However, reactors for ship propulsion can be designed to survive undamaged the large majority of credible accidents. (*Some Aspects of Nuclear Marine Reactor Safety*, by K. Maddocks, read to the Joint Panel on Nuclear Marine Propulsion on 15 December.)

Evening Lectures on Radiation Protection

A series of twelve lectures on radiation protection will be given on Mondays from 7 to 9 p.m. beginning on 25 January at the South-East Essex Technical College in Dagenham. The aim of the syllabus will be to draw attention to the possible dangers to health involved in the use of X-rays and radioactive substances and to present the fundamental principles and methods of radiation protection. The fee for the course will be £1 15*s* 0*d* plus 1*s* for college membership fee.

American Enrichment Capacity and Prices

Present uranium enrichment facilities in the United States could support an atomic energy programme of 40,000 MW without any additional capital investment. The above figure does not include natural uranium or plutonium plants. In addition an enrichment plant for producing low enrichment fuel (up to 3 per cent) could be built for a capital investment of around $500 million with sufficient capacity to sustain a 30,000 to 40,000 MW power programme based on low enrichment reactors. The findings were made by the Atomic Industrial Forum, an association of industrial and educational organisations interested in atomic development. Regarding the prices charged by the USAEC for uranium 235—about $16,000 per kg—the Forum found the price realistic and that it did not contain any direct Government subsidies. The only factor affecting the price of uranium which might be considered a hidden subsidy is the 4 per cent interest charge on capital investment, which could not be maintained under commercial conditions.

The Year at Argonne

Boiling water and fast reactors come into mind when the Argonne National Laboratory is mentioned. But apart from pioneering these two reactor types in America, Argonne has a considerable programme of pure research under way in the field of high energy and solid state physics. Experimental equipment for these departments will include the 12·5 GeV zero-gradient proton synchrotron (Atomic Review, 9 Oct., '59), a 10 MeV Van de Graaff accelerator, and a new high precision mass spectrometer. Backing up the fast reactor programme with applied research in plutonium fuel fabrication is the new pilot production plant, a description of which was the key item in Atomic Review of 20 November, 1959. In 1960 a Fuel Technology Centre, constructed at a cost of $17 million, will come into operation for the study of plutonium metallurgy. Atomic Review reported on the Argonne fast reactor and boiling water reactor programmes last 20 November. The Forum is satisfied that even total elimination of military demand for uranium 235 would leave the price unaffected in spite of increased unit cost.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

GENERAL CHEMICALS DIVISION

has several vacancies for mechanical engineers wishing to make a career in the heavy chemical industry. The work is basically concerned with the maintenance and improvement of chemical plants, and there are plentiful opportunities to broaden experience in plant design and project engineering, construction, and a number of other activities in the Division which are carried out by engineers. Candidates should have a good honours degree in mechanical engineering, preferably have completed a graduate apprenticeship and be in the age range 23-30 years.

The Division spends several million pounds each year on new plants and maintains fully integrated design and factory staffs for the design, construction and maintenance of its installations, including most aspects of mechanical, electrical, civil and instrument engineering. Conditions of service include excellent starting salaries, Pension Fund and Profit-Sharing Scheme. Married men will receive a reasonable refund of removal (including travel) expenses, and to assist them in house purchase, facilities are available in approved cases for substantial loans; in addition, legal charges will be advanced.

Engineers seeking a career with broad interests and excellent opportunities for considerable advancement should write, quoting reference ME22 to:—

STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, GENERAL CHEMICALS DIVISION, CUNARD BUILDING, LIVERPOOL, 3.

B72

SALES DEVELOPMENT

TURNER BROTHERS ASBESTOS CO. LTD. will shortly have two vacancies in their Sales Technical Department at Rochdale for which applications are invited from men with mechanical or chemical engineering background. One position will be for a man to specialise in the Company's asbestos products, mainly textiles, packings and jointings, and the other for a specialist in beltings, mainly transmission and conveyor. The duties will consist principally of survey and development work of a technical nature, and interesting and well paid positions are offered with a Company of world repute. There are possibilities of overseas travel but most of the work will be carried out in the U.K. Comprehensive training will be provided in the Company's Offices and Works.

Applications are invited from men, preferably aged 30 to 38 having commercial ability as well as technical experience. Though preference will be given to applicants with a knowledge of asbestos and belting products, others need not be deterred from applying.

Full particulars of age, education and experience should be sent to the

CHIEF PERSONNEL MANAGER
TURNER BROTHERS ASBESTOS CO. LTD.
ROCHDALE

B 23

WILMOT BREEDEN FELLOWSHIP

Applications are invited for a FELLOWSHIP to be held in association with the College of Advanced Technology, Birmingham. The value of the Fellowship, which is for a two-year term, is £1000 per annum.

A candidate for the Fellowship should normally have had two or three years' research or industrial experience. He should have an honours degree or equivalent qualification and be acceptable to the College of Advanced Technology as a research fellow.

The Wilmot Breeden Fellow would engage in an enterprise of such a character as to require the facilities both of the College and the Company, his time being spent at both. His enterprise may have the character of Scientific Research, Design, Development, a combination of some or all of these, or in some other way to be appropriate to the activities of Wilmot Breeden. The Company is especially concerned with Mechanisms, Electro-Chemistry, Metal Finishing, Metallurgy, Metal Formation, Hydraulics, Electronics.

Full details may be obtained on application to—MR. F. SARGEANT, SECRETARY, WILMOT BREEDEN FELLOWSHIP COMMITTEE, AMINGTON ROAD, BIRMINGHAM, 25.

Final applications must be received by the Secretary before 1st May, 1960. B 29

THE RICHARDSONS WESTGARTH GROUP

PROJECT ENGINEER

Applications are invited for an appointment as a Project Engineer for the preparation of thermal-power generation and supply schemes. The work will require the ability to assess customers' requirements and to evaluate the economics of alternative schemes from basic data and to draw up the final specifications.

A broad knowledge of power generation practice is necessary together with appropriate experience with either a Consulting Engineer or in Industry.

This is a new appointment of senior status and offers considerable opportunity for development to a qualified and experienced engineer who wishes to work on his own initiative and responsibility. The ultimate prospects depend upon the success achieved by the selected applicant in an expanding field of activity.

There are Pension and Life Assurance Schemes in operation.

Apply, in strict confidence, to the Group Personnel Officer, Richardsons Westgarth & Co. Ltd., P.O. Box No. 2, Wallsend, Northumberland, quoting reference number H.-67E. B 66

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

KINGSTON UPON HULL EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

PRINCIPAL: EMLYN JONES, M.Sc., F.R.I.C.

Applications are invited for the following posts:

(*a*) SENIOR LECTURER IN NAVAL ARCHITECTURE. Applicants should be university graduates with honours in Naval Architecture and teaching and/or industrial experience. Corporate Membership of the Institution of Naval Architects a recommendation.

Salary: Burnham Technical Scale: £1550 by £50 to £1750.

(*b*) LECTURER IN ELECTRICAL ENGINEERING to teach to degree and Higher National Certificate standard. Candidates should be honours graduates with experience of heavy current and control systems.

Salary: Burnham Technical Scale: £1370 by £35 to £1510 by £40 to £1550.

(*c*) ASSISTANT (GRADE B) FOR ELECTRICAL ENGINEERING, to teach electrical telecommunications and allied subjects to Ordinary National Certificate and Technicians' Certificate standards.

Salary: Burnham Technical Scale: £700 by £27 10s. to £1112 10s. by £37 10s. to £1150, with additions for training and graduate qualifications and increments for suitable teaching and industrial experience.

Further particulars and application forms, to be returned as soon as possible, may be obtained from the Chief EDUCATION OFFICER, GUILDHALL, KINGSTON UPON HULL.

B 55

SHEFFIELD CORPORATION WATERWORKS

YORKSHIRE DERWENT SCHEME

Applications are invited for the following appointments on the staff of the Waterworks General manager and Engineer (A. B. Baldwin, M.Eng.):—

(*a*) CHIEF ASSISTANT ENGINEERS, I/c Sub-sections. Salary J.N.C. Scale "A" (£1215-£1445). Two vacancies.

(*b*) SENIOR ENGINEERING ASSISTANT. Salary APT. V (£1220-£1375). One vacancy.

Successful applicants will be engaged upon the design and construction of the works of the Yorkshire Derwent Scheme, comprising a River Intake and Treatment Plant, a 40-mile Aqueduct, Service Reservoirs, Pumping Stations and Plant

Applicants must be Chartered Engineers experienced in design and construction of major works. Previous employment on similar water supply schemes would be an advantage.

Appointments are superannuable and subject to medical examination and to the national conditions of service as applied by the City Council.

Applications endorsed with the title of the post applied for are to be forwarded to the undersigned by 23rd January, 1960, stating age, qualifications, past and present appointments (with dates and salaries), details of relevant experience and schemes engaged upon, together with the names of two referees.

JOHN HEYS,
Town Clerk.

TOWN HALL,
SHEFFIELD, 1. A 992

WEST HAM COLLEGE OF TECHNOLOGY

ROMFORD ROAD,

STRATFORD, E.15

PRINCIPAL: G. BULMER, M.A., Ph.D., F.R.I.C.

Required as soon as possible:—

SENIOR LECTURER IN CHEMICAL ENGINEERING—Applicants should have good academic qualifications and industrial experience and be able to teach to University degree standard. Full-time, part-time and sandwich courses for University (Internal) degree, Higher National Certificate and Diploma.

SALARY: £1550 by £50 to £1750 per annum plus London allowance £38/£51.

Further particulars and application forms obtainable from the Principal.

R. OPENSHAW,
CHIEF EDUCATION OFFICER.

B 45

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON and PROVINCES ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially. Overseas tours for which special allowances granted.

Salary in LONDON ranges from £680 (at age 25) to £900 p.a. for men; from £673 to £868 p.a. for women. Somewhat lower in PROVINCES. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 846

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

Applications are invited for the post of HEAD OF THE DEPARTMENT OF AERONAUTICAL ENGINEERING.

The College provides full-time and sandwich courses in various branches of engineering and applied science leading to the award of the Diploma in Technology, and the College Diploma. The person appointed will be responsible for the organisation of Aeronautical Engineering Courses of the Diploma and post-graduate type, and for the teaching of aeronautical engineering subjects throughout the College. He will also be expected to develop post-graduate courses, and to extend the research and consultancy work already carried out, and will be encouraged to undertake consulting work himself.

Applicants should be well qualified professionally and should have had recent industrial experience.

Salary will be paid according to the scale £2100 by £50 to £2250 per annum. A higher salary might be offered to one who is particularly well qualified. The post is pensionable. Further particulars and forms of application may be obtained from the REGISTRAR. (In reply please quote 1/D.)

Applications received in response to previous advertisements are being re-considered. B 37

CIVIL, STRUCTURAL AND PUBLIC HEALTH ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on January 1, 1960 (extension for regular Forces service, Overseas Civil Service, established Civil Service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S64-66/12. B 59

GOVERNMENT OF KENYA

ENGINEER (ELECTRICAL), MINISTRY OF WORKS

To design electrical installations in public institutions, airports and housing.

Contract appointment with prospects of permanency. Salary range £1194-£1863. Gratuity. Free passages. Quarters when available at low rent.

Candidates, 26-45 years, must be A.M.I.E.E. or possess a University degree in electrical engineering and have relevant experience.

Write DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/7/027/D5. A 35

DEVELOPMENT ENGINEER

Required by a progressive and rapidly expanding Mechanical Engineering Organisation, situated in the North of England, to undertake complete responsibility for development of certain important new products. Applicants must have suitable technical qualifications in Mechanical Engineering (at least to H.N.C. standard), must have served an apprenticeship and had adequate drawing office and design experience in mechanical engineering work. This position offers an excellent opportunity for a suitably qualified person with drive and initiative, who is capable of undertaking original design, planning and supervision of Engineering Laboratory Tests, and of co-operating with production and sales staff in overcoming production and service problems. Initial remuneration, £1000-£1200 according to qualifications and experience. Superannuation, Bonus and House Assistance Schemes are in operation. Written applications in confidence to BOX B 39, Offices of ENGINEERING.

Experienced Graduate Engineers

are required by

the manufacturers of the widest range of plastics raw materials and semi-finished products in the Commonwealth.

The Plastics Division of Imperial Chemical Industries Limited is now expanding its Engineering Department in order to keep pace with growing sales in home and overseas markets. Enquiries are invited from:—

Mechanical and Chemical Engineers

holding first or second class honours degrees with some years of industrial experience.

The Division is looking for men of energy, initiative and proved ability. Good starting salaries will be paid immediately, and prospects for the future are excellent. The individual projects upon which candidates will be engaged vary in character and involve all types of engineering, from light precision machine work to heavy process. They include all the planning, layout and procurement associated with the design and erection of large manufacturing units. Some of the work is experimental, directed towards manufacture in new fields.

Conditions of service are good and pension and profit-sharing schemes are in operation. For married men, temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to:—

The Staff Manager,
Imperial Chemical Industries Limited,
Plastics Division,
Black Fan Road, Welwyn Garden City,
Herts. A 943

OFFSITE CIVIL ENGINEER

Graduate Civil Engineer required to work as a member of a design team on refinery and petrochemical plant facilities. He should be a Corporate Member of the Institution of Civil Engineers and should preferably have had 3-5 years' experience with a contractor on design and estimating work on lump sum contracts plus some construction site experience. The work, which is varied, includes harbour and jetty, water intake and outfall design, marshalling yard and road layout work, grading calculations, etc. Knowledge of electronic computer calculation technique would be an advantage.

An above-average salary is offered for this position, according to age and experience. Comprehensive personnel benefits include pension scheme, overtime payment, excellent working conditions, Social Club, etc.

Please write to Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION,
7-10, CHANDOS STREET, LONDON, W.1,
quoting reference H/153

B61

THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH—CERN GENEVA, SWITZERLAND

now possesses the world's biggest accelerator (25 GeV Proton Synchrotron). Specialist staff is required for the operation of this machine and a 600 MeV Synchro Cyclotron, and the construction of research apparatus:

ENGINEER to design and install vacuum systems and to study mechanical design problems.
PHYSICIST to carry out nuclear physics measurements and to act as liaison between accelerator group and visiting experimental teams.
PHYSICIST-ENGINEER to develop ultra high vacuum systems and to perform residual gas studies.
PHYSICIST-ENGINEER to supervise the programming and operation of rotating machines producing current pulses of several hundred amperes, and to design, install and operate power supplies and special electromagnets.
ELECTRICAL ENGINEER to design and supervise the installation and testing of power equipment for beam transport and bubble chamber magnets.
PHYSICIST to work with a team using a large precision cloud chamber in experiments with the 25 GeV Proton Synchrotron.
ELECTRONIC ENGINEER for the technical supervision of small electronic workshop, an instruments maintenance section and an electronic store.
ELECTRONIC ENGINEER or PHYSICIST to develop electronic circuits and instruments.
TECHNICAL ASSISTANT in the operation, installation and maintenance of the Synchro-Cyclotron.
ENGINEER (Heating and Ventilation) to design and execute new site installations, and to modify and maintain existing plant.
ELECTRICAL ENGINEER to supervise the installations maintenance and repair of electrical distribution systems.

Vacancies also exist for experienced DESIGNERS, LABORATORY TECHNICIANS and ACCELERATOR OPERATORS. A few clerical and typing posts may also arise. Good salaries according to qualifications and experience, plus certain allowances. Excellent social security and leave conditions.

Application forms and further information from: MINISTRY OF LABOUR (E9), 26-28, KING STREET, LONDON, S.W.1. B 54

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—(*a*) Roads, pavements, earthworks and stormwater drainage; (*b*) Foul drainage and sewage disposal; (*c*) Water supply and distribution. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially.

Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.c, LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3746) giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 840

UNIVERSITY OF SYDNEY

PETER NICOL RUSSELL CHAIR

OF MECHANICAL ENGINEERING

Applications are invited for the Peter Nicol Russell Chair of Mechanical Engineering. This Chair has become vacant owing to the death of Professor G. G. McDonald.

Salary will be at the rate of £A3750 per annum, plus cost-of-living adjustment. There is a retirement provision under the Professorial Superannuation Scheme.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. The Senate reserves the right to fill the Chair by invitation.

A statement of conditions of appointment and information for candidates may be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close in Australia and London on 15th MARCH, 1960. B 41

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733-£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the INDUSTRIAL RELATIONS OFFICER, WEST MIDLANDS GAS BOARD, 6, AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15. G 841

CIVILIAN INSTRUCTIONAL OFFICER

CIVILIAN INSTRUCTIONAL OFFICER FOR VOCATIONAL TRAINING in Precision Engineering and Instrument Making. Post at H.M. Borstal, Gaynes Hall, Great Staughton, Huntingdon, for man at least 30 on February 12, 1960.

Qualifications: Full apprenticeship plus at least 5 years' practical experience; City and Guilds Certificate (or equivalent) and some teaching experience desirable.

Salary scale, £775 to £900. Prospects of pensionable employment. 44-hour week and holidays with pay. Quarters not provided.

Write PRISON COMMISSION, R.241/251, HORSEFERRY HOUSE, DEAN RYLE STREET, LONDON, S.W.1, for application form.

Closing date, January 29, 1960. B 53

NEW ZEALAND MINISTRY OF WORKS ENGINEERING STAFF

The New Zealand Ministry of Works invites applications for the following vacancies on the Permanen Staff. Positions, qualifications desired and salaries offered are as follow:—

Vacancy No. 1. CIVIL ENGINEERS. Corporate Membership of the Institution of Civil Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 2. ASSISTANT CIVIL ENGINEERS. A University Degree in Civil Engineering, or Graduate Membership of the Institution of Civil Engineers, London, with at least five years of practical experience since commencement of pupilage. Commencing salaries £870 up to £1060 per annum.

Vacancy No. 3. MECHANICAL OR ELECTRICAL ENGINEERS. Corporate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 4. BUILDING SERVICES ENGINEERS. Corporate Membership of the Institution of Heating and Ventilating Engineers, London. Commencing salaries up to £1450 per annum.

Vacancy No. 5. ASSISTANT MECHANICAL OR ELECTRICAL ENGINEERS. A University Degree in Mechanical Engineering or Graduate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with at least five years experience since commencement of pupilage. Commencing salaries £870 up to £1060 per annum.

Vacancy No. 6. ASSISTANT BUILDING SERVICES ENGINEERS. Graduate Membership of the Institution of Heating and Ventilating Engineers, London, with at least five years experience since commencement of pupilage. Commencing salaries £870 to £1060 per annum.

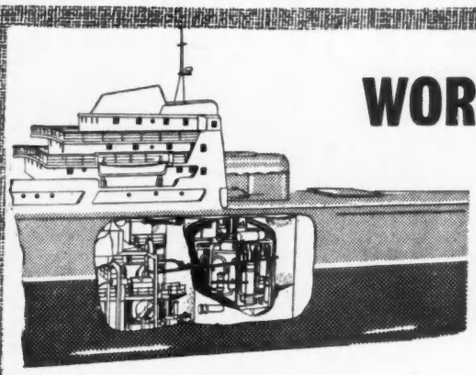
Civil Engineers and Assistant Engineers must have had experience in the design or construction of multi-storied reinforced concrete buildings or bridges and other structures. For the other vacancies experience is necessary in the design and installation of services or equipment for one or more of the following: heating and ventilating, air conditioning, hot and cold water or sewerage services, laundries, kitchens, boilerhouses, lifts and other mechanical services in offices, schools, hospitals, hotels, telephone exchanges, printing works, defence establishments, etc. All appointees will be required to undertake work of this nature.

APPLICANTS MUST BE RESIDENT IN THE UNITED KINGDOM OR EIRE AND HAVE FULFILLED NATIONAL SERVICE OBLIGATIONS.

Enquiries, mentioning this publication and stating the Vacancy Number and the position sought, should be addressed to the HIGH COMMISSIONER FOR NEW ZEALAND, 415 STRAND, LONDON, W.C.2. Full details of duties, experience required, general information on the conditions of employment in the New Zealand Public Service and application forms will then be supplied. A 980

AIR MINISTRY

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and M.T.C.A. Stations. The work of Station Engineer (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineer (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Commencing salary according to age, qualifications and experience. Salary ranges £680 to £850. Candidates must hold O.N.C. Electrical or Mechanical/City and Guilds Electrical Technicians Certificate/2nd Class M.O.T. Certificate, or equivalent, and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering, preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidates with supervisory experience. Opportunities for promotion up to Technical Grade A, maximum salary £1565 (National Rate) and pension prospects. Five-day week, three weeks three days leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applications normally from natural born British subjects only, up to age 55 years. —Write, stating age, qualifications and experience, to MANAGER (P.E.1), PROFESSIONAL AND EXECUTIVE REGISTER, MINISTRY OF LABOUR, ATLANTIC HOUSE, FARRINGDON STREET, LONDON, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 845



WORLD WIDE NUCLEAR PROJECTS

HAWKER SIDDELEY NUCLEAR POWER COMPANY LIMITED

offer the following LONG RANGE CAREERS

PROJECT DEPARTMENT

(i) **ENGINEER METALLURGIST :** to study fuel element problems and to design and test, in and out of pile, new types of fuel element. Experience in the fields of welding, non-destructive testing, irradiation experiments or quality control would be an advantage.

(ii) **SENIOR MECHANICAL ENGINEER :** for work on the design, specification and tendering of complete nuclear power plants. Experience of similar work in the fields of conventional power plant, chemical plant or marine plant is essential.

(iii) **ENGINEERS/PHYSICISTS :** to carry out experimental engineering investigations in connection with the development of the organic moderated reactor.

(iv) **PHYSICIST :** to assist in the nuclear analysis of reactors.

(v) **ELECTRICAL ENGINEER :** to assist in the study of advanced power generation projects including thermionic convertors, plasma generation and fuel cells.

(vi) **PROJECT ENGINEERS :** to assist in various feasibility and design studies of reactor systems for aeronautical and marine propulsion.

(vii) **CHEMICAL ENGINEERS :** for interesting work on the design and development of organic moderated reactors and also on large-scale energy consuming processes. The work will follow through from initial design investigations to pilot plant and full scale application on a rapid time schedule.

Applicants for all the above posts should have an Honours degree

DEVELOPMENT DEPARTMENT

(i) **INSTRUMENTATION ENGINEERS/PHYSICISTS:** to work on the development of instrumentation systems and instruments for use in advanced type reactors and associated equipment.

Degree essential.

(ii) **SENIOR MECHANICAL DESIGN ENGINEER:** to co-ordinate a design team working on design, manufacture and commissioning of experimental facilities for use in reactors. The major interests will include heat transfer, fluid flow and instrumentation, mechanical design and manufacture in stainless steel.

Degree essential.

(iii) **JUNIOR DESIGN/DEVELOPMENT ENGINEERS:** to assist in the design and operation of test rigs and in pile and out of pile loops. Applicants with Higher National Certificate or equivalent will be considered for these junior posts.

MATERIALS DEPARTMENT

(i) **SECTION LEADER :** for physical metallurgy and general materials section. Duties will include the supervision of research and development work of a general metallurgical nature and also research investigations in thermoelectrics and high temperature materials.

Good Honours degree essential.

(ii) **PHYSICISTS, METALLURGISTS AND GENERAL SCIENCE GRADUATES:** for interesting and varied work on numerous problems connected with new and conventional materials used in the nuclear engineering and allied fields.

All the above posts are progressive and are pensionable after the normal qualifying period.

Applications in writing please, stating post applied for, to :

The Personnel Officer,
HAWKER SIDDELEY NUCLEAR POWER COMPANY LIMITED,
Sutton Lane, Langley, Bucks B 44

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on January 1, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London), £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S64/8. B 52

UNIVERSITY COLLEGE LONDON

GOWER STREET, W.C.1

Physics Department (Professor H. S. W. Massey) requires (1) qualified MECHANICAL ENGINEER and (2) DESIGNER-DRAUGHTSMAN (Plant) to work at the College on large nuclear particle detector involving fast pressure cycling of liquids for use at National Institute for Research in Nuclear Science, Harwell. Applications to Secretary of the College, from whom further particulars may be obtained. B 46

CITY AND COUNTY OF BRISTOL

EDUCATION COMMITTEE

BRISTOL TECHNICAL COLLEGE

DEPARTMENT OF ENGINEERING

The above College is being formed by the separation, as from 1st September, 1960, of the present College of Technology into a College of Advanced Technology and a Regional College, the Bristol Technical College. The Governors invite applications for the following new posts, to take effect from 1st May, 1960. Applicants should be graduates or equivalent with industrial, teaching and preferably some administrative experience. The Department will provide courses in Mechanical and Electrical Engineering up to Ordinary National Certificate level, together with all craft courses in Engineering. The successful candidates will be directly responsible to the Head of Department for the appropriate sections.

1. SENIOR LECTURER in Mechanical Engineering.
2. SENIOR LECTURER in Electrical Engineering.

Burnham Technical Scale salary, £1550 by £50 to £1750 per annum.

Application forms, returnable as soon as possible, and details, from REGISTRAR, COLLEGE OF TECHNOLOGY, ASHLEY DOWN, BRISTOL, 6 B.60

UNIVERSITY OF GLASGOW

I.C.I. RESEARCH FELLOWSHIPS

Applications are invited for I.C.I. RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Engineering, Pharmacology, or Physics to which some appointments may be made during the current academic year. The appointments will date from 1st October, 1960. The Fellows will hold the status of Lecturers in the University. The salary will depend upon qualifications and experience, but will be within the range £700 to £1000 per annum, together with F.S.S.U. benefits and family allowances.

Applications (8 copies), with a list of publications and names of two referees, should be sent not later than 29th February, 1960, to the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
SECRETARY OF UNIVERSITY COURT.
B 48

ENGINEERING INSPECTORS

MINISTRY OF HOUSING AND

LOCAL GOVERNMENT

4 pensionable posts in London for men and women at least 35 on January 1, 1960. Duties involve investigation of technical and economic merits of engineering proposals submitted to the Ministry. Qualifications: A.M.I.C.E., and wide experience of civil engineering work. Special knowledge and experience in one or more of the following fields essential: sewerage and sewage disposal, sea defence, water supply. Honours degree in Engineering an advantage. Starting salary (men, London) from £1600 at 35 to £1890 (or higher if exceptionally well qualified or experienced) at 40 or over. Scale maximum £2450 (London). Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form quoting 85085/60/11. Closing date, 16th February, 1960. B 51

HERTFORDSHIRE COUNTY COUNCIL

TECHNICAL INFORMATION SERVICE

INDUSTRIAL LIAISON OFFICER

Applications are invited from graduates or other suitably qualified individuals with industrial experience, preferably in management or information work, for a new appointment as INDUSTRIAL LIAISON OFFICER.

The post calls for an aptitude in discussing technical problems and the initiative to encourage firms to utilise local and national sources of information.

Salary: £1370 p.a. by £35 to £1550 p.a., plus travel allowances.

Further details from the COUNTY EDUCATION OFFICER, COUNTY HALL, HERTFORD, to whom completed applications should be returned by February 12th, 1960. B 40

JOSEPH LUCAS (ELECTRICAL) LIMITED

MECHANICAL ENGINEERS

There are vacancies in our laboratories for

SENIOR TECHNICAL ASSISTANTS

with Higher National Certificate, to work on a wide range of investigations associated with the performance of internal combustion engines including starting at low temperatures. Applicants should have had previous engine experience, preferably including engine testing.

The posts are permanent and pensionable. Five-day week.

Apply in writing, stating age, qualifications and experience, to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL) LIMITED, Great King Street, Birmingham 19, quoting reference PM/D/368. B33

PORTLAND BLUE CIRCLE CEMENT

DRAUGHTSMEN

required by

ASSOCIATED PORTLAND CEMENT MANUFACTURERS LTD:

to work in Area Engineer's Office, Stone Castle, Greenhithe, Kent, on drawings for the installations of new plant on a long term basis. Profit sharing and pension schemes in operation. Applicants, who should have some experience in bulk mechanical handling, should apply in writing stating training, qualifications, experience, age and salary required. A 926

Applications invited for the position of

" PERSONAL ASSISTANT to the GENERAL MANAGER "

Controls Division—Hopkinsons Limited, Huddersfield.

Applicants to be within the 30/40 year age group, preferably with an Engineering Degree, administrative ability, and a practical knowledge of the light electrical engineering field.

Applications to be addressed to the General Manager. A998

draughtsmen

To meet an expanding programme of development,

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PLASTICS DIVISION

urgently need more Draughtsmen. In particular, men are required experienced in work associated with process plant, e.g., piping, heating and ventilating, drying, powder conveying and packing. Mechanical draughtsmen are also needed since the programme includes development work in novel processes which are essentially mechanical in nature. There are vacancies too for men with instrument and electrical design experience.

Good starting salaries will be paid and pension and profit sharing schemes are in operation. For married men temporary lodging allowances are available and assistance is given towards house purchase and removal expenses.

Apply briefly to the Staff Manager,

IMPERIAL CHEMICAL INDUSTRIES LIMITED
PLASTICS DIVISION
BLACK FAN ROAD, WELWYN GARDEN CITY, HERTS.

A 939

CITY OF SHEFFIELD EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

DEPARTMENT OF ENGINEERING

Applications are invited for the following additional posts resulting from developments in the work of the Department in the new buildings of the College:—

(*a*) SENIOR LECTURER IN PRODUCTION ENGINEERING

Applicants should have graduate or equivalent qualifications and be adequately experienced in both industry and in teaching.

The person appointed will be expected to teach Machine Tool Theory, Metrology and other Production Engineering subjects of the new scheme of the Institution of Production Engineers to Higher National Certificate and Higher National Diploma students. He will be responsible for the new, well-equipped Machine Tool and Metrology laboratories. He will be expected to assist in the promotion of research and laboratory work in Production Engineering subjects, in the development of the Higher National Diploma course and in organising special advanced courses in production subjects. An interest in the application of Automatic Control to manufacturing equipment will be welcomed.

Salary: £1550 by £50 to £1750 per annum.

(*b*) ASSISTANT (GRADE B)—MECHANICAL—(3 POSTS) to teach mainly in part-time day classes a selection from Engineering Science, Applied Mechanics, Engineering Drawing, Mathematics and Applied Heat for Ordinary National Certificate students in Mechanical and Electrical Engineering.

More advanced teaching will be available for a suitably qualified and experienced teacher.

Applicants should have graduate or equivalent qualifications in Mechanical Engineering, with adequate and suitable experience in both industry and teaching.

Salary: £700 by £27 10s. 0d. to £1150 per annum with allowances for degree, industrial and teaching experience.

Application Forms, obtainable from the undersigned (s.a.e.) at P.O. BOX 67, SHEFFIELD, 1, should be returned within 14 days of the appearance of this advertisement.

T. H. TUNN,
DIRECTOR OF EDUCATION. B 64

UNIVERSITY OF LONDON

Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology or Physics. The Fellowships will be within the range of £800-£1000 per annum and will normally be tenable from 1 October, 1960, for three years. Family allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1. Applications must be received not later than 30th April, 1960.

UNIVERSITY OF LONDON: Applications are invited for a TURNER & NEWALL RESEARCH FELLOWSHIP in Engineering, Inorganic Chemistry or Physics. The Fellowship will be within the range of £800-£1000 per annum and will normally be tenable from 1st October, 1960, for three years. Family Allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1. Applications must be received not later than 30th April, 1960.

G 843

BRITISH TRANSPORT DOCKS

BRITISH TRANSPORT DOCKS invite applications for the positions of (1) Senior Engineering Assistant (Civil) at South Wales Docks (office at Barry, Glamorgan) and (2) Engineering Assistant (Civil) at Goole, Yorkshire.

Candidates should have experience in the design, specification construction and execution of general civil engineering works, preferably with knowledge of dock and harbour installations. Professional qualifications desirable. Salary range post (1), £1095-£1265 per annum; post (2), £1045-£1150 per annum. Contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, education, training, experience and qualifications to: STAFF AND ESTABLISHMENT OFFICER, BRITISH TRANSPORT DOCKS (E), 163, EUSTON ROAD, LONDON, N.W.1, to arrive not later than Monday, 25th January, 1960. B 50

SITE ENGINEER

A site engineer is required by F. H. Lloyd and Company Limited, to take charge of the erection and installation of a steel foundry for the Indian Railway Board at Chittaranjan, West Bengal, India, for which F. H. Lloyd and Company Limited are acting as consultants.

Candidates should have similar experience on a major construction site, preferably overseas, and have a high degree of technical competence and executive ability. A professional engineering qualification would be an advantage.

Before leaving for India the selected applicant will be required to work initially at F. H. Lloyd and Company Limited, Wednesbury, and thereafter to India for a period of up to 5 years. The post is advertised as a permanent career with F. H. Lloyd and Company Limited if the applicant so wishes.

Salary will be equivalent to £3000 per annum, tax free in India. Accommodation in India will be provided and generous leave facilities will be arranged.

The appointment is subject to the applicant satisfying the conditions imposed by the Indian Railway Board.

Apply giving full details to Chief Engineer, F. H. Lloyd and Company Limited, G.P.O. Box 5, Wednesbury, Staffs, not later than January 31, 1960.

B 73

ENGINEERS AND DRAUGHTSMEN

CONSULTING ENGINEERS urgently require additional staff in London and Darlington, engineers and draughtsmen for both reinforced concrete and steelwork.—Full particulars to F. R. BULLEN & PARTNERS, DACRE HOUSE, DEAN FARRAR STREET, S.W.1. A 981

APPOINTMENTS OPEN

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS. Due to expansion, a company specialising in centralised lubrication equipment require additional engineers to work in the company's London Office (Edmonton, N.18) or as Sheffield and Scottish area engineers respectively. Previous practical or sales experience of steelworks, heavy industry or lubrication an advantage.—Applications stating age, qualifications, experience, etc., will be treated in the strictest confidence, to be addressed to: MANAGING DIRECTOR, CENTRALUBE LTD., PARK ROYAL ROAD, LONDON, N.W.10. ELGar 3751. B 18

METROPOLITAN WATER BOARD

have vacancies for

ASSISTANT ENGINEERS (CIVIL)

Salary scale, £980-£1210 per annum.

Applicants must be Corporate Members of the Institution of Civil Engineers and must have had sound engineering experience.

ENGINEERING ASSISTANTS (CIVIL AND ELECTRICAL)

Salary scale, £700 (at age 21) to £945 per annum.

Applicants must have passed or be exempted from passing Parts I and II (or Sections A and B) of the examinations of the Institution of Civil Engineers or Electrical Engineers.

Permanent pensionable posts.

Commencing salaries according to age and experience.

Good opportunities for promotion.

Housing accommodation may be available at reasonable rental.

Office hours, 8.45 a.m. to 4.45 p.m. (Monday to Friday).

Staff restaurant, sports club, etc.

Forms of application from the undersigned, quoting reference (EG).

S. D. ASKEW,
CLERK TO THE BOARD.

NEW RIVER HEAD,
ROSEBERY AVENUE, E.C.1.

B 69

PRODUCTION DEVELOPMENT

STAFF REQUIRED

for interesting new projects covering the following branches of Production Engineering:—

PLANNING AND TOOL DESIGN for machined parts.

PLANNING AND TOOL DESIGN for major assemblies and plate details.

PLANNING of Aircraft **ELECTRICAL INSTALLATIONS.**

Men with experience of one or more of the above are also required to work in conjunction with Aircraft Designers to advise on ways of achieving the best design of component for production.

DESIGN OF TOOLS and special machines for manufacture of components for **ATOMIC ENERGY PROJECTS.**

CUTTING TOOL DEVELOPMENT involving advanced techniques on light alloy and ultra high tensile steels, etc.

Applications from suitably experienced candidates should be sent to the PERSONNEL OFFICER, FAIREY AVIATION LIMITED, HAYES, MIDDLESEX. B 16

SENIOR PIPING DESIGNER DRAUGHTSMEN

A few vacancies exist for Senior Piping Designers. Top positions are available with us in this field, but consideration will be given only to men who have considerable experience in piping design and layout of refinery and chemical plants, or in related industries. Our Piping Designer-Draughtsmen are of a high standard and we therefore can consider only men of equal calibre.

Our permanent staff benefit from above average salaries, liberal personnel benefits, pension scheme, excellent working conditions, overtime payment, Social Club, etc. If you are interested and qualify, you are invited to write to, or telephone,

Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION,

7-10, CHANDOS STREET, LONDON, W.1. Tel.: MUSeum 4010

quoting reference H/150. B 62

HEATING AND VENTILATING ASSISTANT

HEATING AND VENTILATING ASSISTANT required by Westminster consultants. Air conditioning experience on industrial work advantageous. Should be able to "lead" design of schemes under general supervision. Age range, say, 35-40. Salary necessary to be decided on experience and qualifications.—BOX B 32, Offices of ENGINEERING.

MECHANICAL ENGINEERS

YORKSHIRE IMPERIAL METALS LIMITED

is the largest manufacturer of copper and copper alloy tubes and fittings in Europe and compares favourably, both in size and equipment, with the largest producers in the U.S.A. Further and extensive modernisation of the manufacturing facilities is contemplated together with research and development work on new methods of tube and product manufacture.

Mechanical Engineers of high calibre are required for design and maintenance duties. Preference will be given to candidates with high professional qualifications and appropriate experience, but due regard will be paid to potential abilities and personal qualities which will assist in collaboration with other members of the Staff.

The appointments will, in the first instance, be at the Works in Leeds but there are also factories at Birmingham, Liverpool, Glasgow, Dundee and Swansea, where new appointments may be made in the future. Salaries offered to successful applicants will be commensurate with qualifications and experience.

The Company operates a Pension and Life Assurance Scheme, Profit-Sharing Scheme, and has excellent welfare facilities. Consideration would be given to candidates requiring assistance when removing home.

Applications, giving full details of age, qualifications, experience and present salary should be marked "Engineer" and addressed to:—

THE CHIEF PERSONNEL OFFICER,
YORKSHIRE IMPERIAL METALS LTD.,
P.O. BOX 166,
LEEDS.

B 58

QUALIFIED MECHANICAL ENGINEER

QUALIFIED MECHANICAL ENGINEER required to control production and maintain steam generation plant and Chipboard machinery in new factory erecting in Australia. Previous timber experience desirable but not essential. Applicant must be willing to undergo Continental training before emigration within three months.—Write stating age, previous experience and family circumstances, to CHIPBOARD, 22, BISHOPSGATE, LONDON, E.C.2, BEFORE INTERVIEW LONDON 20/22 JANUARY. B 68

DESIGNER AND DESIGN DRAUGHTSMEN

Designer and design draughtsmen required for precision components used in the manufacture of internal combustion engines.—Write, stating age, experience and present salary, BOX B 67, Offices of ENGINEERING.

DESIGN DRAUGHTSMEN

DESIGN DRAUGHTSMEN required for a unit situated in the North West London area. Applicants should be over 28 years of age and will be required to show evidence of extensive practical experience, coupled with a capability of developing new production techniques, including automatic handling. It is desirable that successful applicants should have reached a H.N.C. standard of education. Salary: £1100 per annum.—BOX B 65, Offices of ENGINEERING.

MECHANICAL ENGINEERING DRAUGHTSMAN

MECHANICAL ENGINEERING DRAUGHTSMAN, preferably holding H.N.C. or equivalent, experienced in textile dyeing and finishing machinery.—Applications, stating age, experience, qualifications and salary required to THE CHIEF ENGINEER, THE BRADFORD DYERS' ASSOCIATION, LTD., 39, WELL STREET, BRADFORD, 1. B 19

DESIGN ENGINEER

Midland Firm requires a DESIGN ENGINEER in the field of gas compressors. Good academic qualifications are essential to cope with the wide range of engineering problems encountered. This post carries responsibility with excellent opportunities in a company where personal contact is made with all departments at all levels.—BOX A989, Offices of ENGINEERING.

WORKS ENGINEER

WORKS ENGINEER required by International Manufacturers of surgical dressings, for their North Wales factory. Duties will include maintenance, installation and development of light mechanical machinery. Age 23/30. Good Engineering Degree essential. Salary, £850-£1000 per annum. Pension Scheme. Excellent working conditions.—Apply giving fullest details, to BOX B 49, Offices of ENGINEERING.

CANADA

PLANT SUPERINTENDENT required for small steam Power Station in Canadian coastal area. Candidates should be well educated and have had several years' experience of electrical power generation. They will be expected to take complete charge of plant operation and maintenance. Salary will be around 7,500 Canadian dollars p.a. Applications, giving full details of age, education, qualifications and experience, to MESSRS. MACKNESS & SHIPLEY, PARLIAMENT MANSIONS, ABBEY ORCHARD STREET, LONDON, S.W.1, quoting reference 2465. B 42

SALES ENGINEERS

SALES ENGINEERS required by Compressor Manufacturers for expansion of Sales Dept. Candidates should be qualified Mechanical Engineers holding H.N.C. or equivalent with sound practical knowledge and preferably sales experience in allied field. First class prospects for the right men. Full particulars including education, engineering training and qualifications, previous experience, age and salary required, to THE MANAGING DIRECTOR, REAVELL & CO., LTD., RANELAGH WORKS, IPSWICH. B 38

ENGLISH ELECTRIC

require

RESEARCH AND DEVELOPMENT ENGINEERS

at

The Mechanical Engineering Laboratories, Whetstone, Near Leicester,

for the Solid Mechanics Group, which undertakes both theoretical and experimental investigations relating to strength of materials and vibrations, including fundamental Research. Applications are invited from qualified engineers, physicists or mathematicians, in the age range 20-35, in particular from those interested in photo-elasticity theory of structures or vibrations.

There is also a vacancy for a

STRUCTURAL ENGINEER

who will be employed on the application of minimum weight principals to the design of diesel locomotive structures in which the analytical work will be backed by both laboratory and field tests. The successful applicant will be a member of a team dealing with structural problems in general.

Please write giving details of qualifications and experience to **DEPT. C.P.S., MARCONI HOUSE, 336/7 STRAND, LONDON, W.C.2,** quoting reference EG 1995F. B 57

DEVELOPMENT ENGINEERS

required by a leading instrument manufacturer in South East Essex for work on further application of a major project.

SENIOR ENGINEER

preferably a PHYSICIST aged about 30 years, with a good degree, to act as deputy to the laboratory head in the administrative and technical fields. Good knowledge of engineering and optics are essential while some electronic experience and interest in photography would be an advantage. Starting salary within the range £1200/£1700 according to age, experience and qualifications, with ample scope for future progress.

PROJECT ENGINEERS

preferably PHYSICISTS and MECHANICAL ENGINEERS, with a minimum qualification of H.N.C., for work involving mechanical engineering and design, electrical design and the mechanics of optical and photographic systems. Starting salary within the range £850/£1150 according to age, experience and qualifications, with ample scope for future progress.

A contributory pension scheme and life assurance arrangements are available and housing assistance may be arranged in suitable cases after a satisfactory probationary period.

Adjacent Central Line and other public transport services.

Applications, which can be made in the strictest confidence, should give full particulars of qualifications, previous experience and salary required and be addressed to BOX B 8, Offices of ENGINEERING.

MEN WITH AMBITION

Applications are invited from those with ambition to join expanding sales organisation. Successful applicant, who will be paid salary and expenses, will be required to operate from LEEDS and will be responsible direct to Principal. Must have sound engineering background and possess current driving licence. Age 30-40.—BOX B 28, Offices of ENGINEERING.

APPOINTMENTS WANTED

QUALIFIED ENGINEER

QUALIFIED ENGINEER shortly travelling extensively Middle East, India, wishes to represent firms, manufacturers of engineering materials, ferrous and light metals and alloys, plastics, adhesives, bearings, clutches, seals, drives, couplings, etc.—BOX B 63, Offices of ENGINEERING.

MSL *have been retained to advise on the appointment of a*

CHIEF PRODUCT RESEARCH ENGINEER

for

George Angus & Co. Ltd., Oil Seal Division, Wallsend, Northumberland.

He will be responsible to the Chief Engineer for investigating problems associated with rotating shaft seals and will assume some of the responsibility for customer liaison in Europe.

Candidates should be between the ages of 30 and 45 and must be university trained and qualified to at least B.Sc. Eng. standard and preferably also A.M.I.Mech.E. They should have served an apprenticeship or pupilage covering practical workshop training in fitting and machine shops, at least, and have had several years experience in a technical capacity in automobile, aircraft, machine tool or light engineering. Experience of research is not essential.

Remuneration initially will be up to £2,000 per annum. Contributory pension scheme.

Please send brief details in confidence quoting reference F.1929 to G. K. Dickinson. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

B 70

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.) .. £100
per half page £54
per quarter page £29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.) .. £100
per half page £54
per quarter page £29
per single column inch .. £2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line 4s. 6d
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

Company Meetings

Quarter page £29 : half page £54 : full page £100

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing Screen 100.

ORDERS TO: "Engineering," 36, Bedford Street, London, W.C.2 Telephone TEMple Bar 3663

COMPANY MEETINGS

HAWKER SIDDELEY GROUP

(SIR THOMAS SOPWITH'S REPORT to Shareholders).

This is the twenty-fourth Annual General Meeting of your company. I believe that we are now embarking on a phase of development for this Group which could be one of the most rewarding in our history.

You know that we are making offers to the de Havilland and Blackburn companies and we have already acquired Follands.

In doing this, we are trying to meet the declared policy of the Government and, although we were not particularly anxious to add to our aircraft interests in the U.K., this merging of these companies will consolidate the position of the Hawker Siddeley Aviation Company as the foremost aviation enterprise on this side of the Atlantic and put it in an even stronger position to carry out any project in aviation, civil or military, or in allied industries, which the Government may have to offer.

We have taken the lead in this matter. I sincerely hope that the Government will keep faith and place the contracts necessary for us to function as the strongest technical, scientific and production company in the business.

Our efforts on the industrial side have by no means slackened—indeed they have been intensified and are now bringing their reward. All the companies have made considerable progress, some of it quite remarkable, and I can now say with confidence that we have established the Hawker Siddeley Group as a powerful, balanced and stable business.

Overall, I can say that with nearly six months of the current year behind us, and despite the recession in Canada, the results of the Group should not disappoint you and will again provide ample cover for dividends at the same rate as last year.

The turnover of the Group last year was approximately £260 million.

The total profit, after taxation, attributable to Hawker Siddeley Group rose by more than £1,000,000 to £6,250,957, and your Board has recommended a final dividend of 7 per cent. less tax, making a total of 10 per cent. less tax for the year.

While we in this Group continue to do our utmost in developing export trade, we are at a very serious disadvantage in the all important field of long term export credits. Foreign governments back their industries' efforts in world markets to an extent which is unknown in this country.

It seems to me that the Government and the City of London could devise some method by which our overseas sales could enjoy competitive long-term credit financing. B 71

THE UNITED STEEL COMPANIES

INCREASING DEMAND

SIR WALTER BENTON JONES ON THE OUTLOOK

The annual general meeting of The United Steel Companies, Limited, will be held on January 28 at The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.

The following is the circulated statement of the Chairman, Sir Walter Benton Jones, Bt.:—

INTRODUCTION

A company, by its constitution, has a board of directors appointed by the shareholders, and the directors appoint one of their number to be their chairman. The directors of our company have appointed me to be their chairman and I have had the honour to occupy this position for a number of years.

The statement I am making, it is true, is my own composition. Nevertheless, in effect, it is an elaboration of the Directors' Report, but I am allowed the privilege of putting in a few odds and ends which are *obiter dicta*, as indeed is this introduction.

In composing a statement which is in the nature of an annual review, it can cover many subjects, but it is open to doubt if long statements are read by many. On this occasion I shall try to be brief. This is not a discourtesy, it is because I want to point a highlight on a particular subject—the technical changes which are taking place in the making of iron and steel.

To assist those of you who will find interest in the working of our Branches, as I hope all of you will, a short reference is made to each of them in an appendix.

NATIONALISATION

For the present the overloaded nationalisation wagon has not had the Steel Industry added to its load. Is it an oversimplification to say that fundamentally private enterprise is personal whereas nationalisation is impersonal? The people of our country have resolved to retain personal enterprise and it is to be hoped that this resolution will become still stronger as time passes.

Our company is composed of a number of units each of which is a personal community. In general terms everybody knows everybody else. And all these communities over a long period of years have got to know one another so well and to help one another so willingly and intelligently that the whole company regards itself and conducts itself as a community of persons—a community of 35,000 operators and 35,000 proprietors. That ideal has been, and in the future will still be, the aim of the administration.

The things I am going to talk about are:

(1) How we have come through the recent recession.

(2) In a purely technical story, the recent revolutionary processes of making iron and steel which have been and are still taking place, and what we have done and are doing about them.

(3) Our near-future prospects.

(4) Our present financial state.

THE RECENT RECESSION

In November, 1958, when my last statement was written, we had reached the end of a long period of striving to make production catch up with demand. We were uncertain whether this was a lull or the beginning of a slump. We all hoped it was a lull which might not last longer than the third quarter of the current year. This hope has been realised. I need not enumerate all our fears and hopes in the meantime and the many factors and markets on which our fortunes depended.

Although we do not make wide strip, for which the demand has not diminished, we have a substantial shareholding in John Summers & Sons who specialise in this product, and we ourselves are the largest makers of medium and narrow strip in the United Kingdom.

Excluding wide strip we own 15·6 per cent. of the country's steelmaking capacity and we were successful this year in producing 17·2 per cent. of its output.

STEEL STORY

We speak of steel as it it were a single thing. In fact, although the greater part is what we may call, with great respect, common or garden steel, there are infinite varieties of high grade special steels. They are made for a hundred and one purposes. We make both common or garden steel and a great variety of special steels.

Common or garden steel is made in two ways, one we call the hot metal process and the other we call the cold metal process.

In the hot metal process molten iron is charged directly from the blast furnace into steel converters or furnaces in which the iron is converted into steel. In the cold metal process a mixture of iron and steel scrap together with cold pig iron is remelted and refined in steel furnaces.

It is estimated that in our country 75 per cent. of steel is made by the hot metal process and 25 per cent. by the cold metal process.

In previous statements I have told you of the progress we have made at Appleby-Frodingham in the working of iron ore and in beneficiation of ore and in blast furnace practice. The evolutionary stages now make it possible for us to make twice as much iron in our blast furnaces, which are large and modern, as was possible ten years ago and at the same time to reduce by a third the amount of fuel needed to make a ton of iron.

In step with these evolutionary developments in iron making we have been looking hard at steel.

Steel makers all over the world are just now examining and introducing revolutionary methods of converting iron into steel.

The outstanding feature in this revolution is the use of oxygen—or correctly speaking the substitution of neat oxygen for combustion and refining for atmospheric air of which oxygen is only one-fifth part. There is nothing new in the idea of using neat oxygen for these purposes, but it has not been used generally in the past either because existing methods were sufficiently economical or because the methods of isolating oxygen on a large scale had not been sufficiently developed.

There are several methods of introducing oxygen. Some require the substitution of entirely new steelmaking plant, but some can be applied by adaptation of existing plant.

At Appleby-Frodingham works, where we make by the hot metal process 1,400,000 tons of steel in a year, we have invented a method of our own which we call the Ajax process. This has already been applied to two of the Appleby-Frodingham ten steel furnaces, and the result has been to increase their production by about 75 per cent. In the Ajax process also there is a reduction in fuel consumption of over 70 per cent. This year the process will be applied to a third furnace. We are engaged in building an oxygen making plant to augment our supply to these furnaces.

Incidentally, our Ajax process equipment is patented and a firm of furnace builders has been licensed to manufacture it to our designs, for other steelmakers.

In the cold metal process, following careful and full examination we have reached the conclusion that future economy and efficiency indicate that the most forward looking policy would be to discard the type of steel furnaces which are commonly used and which are known as open-hearth furnaces and to substitute for them electric furnaces. At Samuel Fox for some years we have been making special steel in increasing quantities in electric furnaces. But at Steel, Peech and Tozer, where we make by the cold metal process over 1,000,000 tons of steel a year in open-hearth furnaces, although these furnaces are comparatively modern, we intend over the next five years to replace them step by step with electric furnaces.

We believe there are no other steelworks in this country or in the world of comparable size in which up to now electric steel melting has been substituted for melting by the cold metal process in open-hearth furnaces.

Another development in which we are engaged is what is known as continuous casting.

In normal practice the ingots into which steel is first cast are very large and the practice is to reduce the size by a first rolling in gigantic primary rolling mills, after which they pass into small mills for shaping into different sizes.

In many cases if the steel could be cast into smaller forms directly it leaves the steel furnace, the large primary rolling mill would not be needed. Members of our staff have been engaged for some time in developing and improving an experimental continuous casting plant at the Barrow Steel Works which we manage on behalf of the Iron and Steel Holding and Realisation Agency. Continuous casting has now been proved to be successful and we are satisfied that it can be used commercially in many cases, not all of which have yet been developed.

We have completed an agreement with Concast A.G. of Zurich which enables us to use their patents and know-how without charge for machines which we may build for ourselves, but we are also entitled to build machines for others under licence.

I have mentioned these purely technical matters because taken together they do constitute a very large step forward in the making of steel. They affect a large part of our undertaking. We have started upon them early and have not waited to follow developments which have been first proved by others.

There are many other things in our steel works which we have done and are doing and which are not only modernising processes, but also are extensions and elaborations of products. For example, at Samuel Fox, where we made last year about 333,000 tons of special and alloy steels including 40,000 tons of stainless steel, the works have been very largely rebuilt in the last ten years. But the developments through the stages of iron and steel making to which I have referred are new developments. They are far reaching and are the beginnings of what it seems may soon become common practice.

NEAR FUTURE PROSPECTS

In general, the recession ended in the early spring of this year. Since that time there has been an increasing improvement in the demand for all our steel products except for those manufactured by certain specialised departments which in the main provide materials for the railways and the coal mining industry but in some cases we have been able to substitute other products.

The intense demand for consumer goods, the restocking programme by all consumers together with fair prospects in the export market lead to an encouraging picture.

It is true that the demand for some capital goods has not yet reached the previous high level but we believe we shall continue to work to near full capacity and the prospects of the company for this current financial year are therefore bright.

PRESENT FINANCIAL STATE

The Report and Accounts with their notes are so full and so clear that it would be only repetition for me to point to this or that in any part of the Balance Sheet or in the Profit and Loss Account.

The charge for depreciation together with the transfers to fixed assets replacement reserve amount to £7,099,000 for the year and the provision for taxation to £7,091,000. Current assets less liabilities at £26,619,000 are £2,942,000 greater than in the previous year. Quoted trade investments stand in our books at £1,339,000; at 30th September their market value was £4,314,000. Our cash and short term securities at about £7½ million are little changed.

Perhaps the most interesting and easily appreciated records are the graphs at the end of the Accounts which show the actual rate of output and the net earnings in the years from 1951 up to the present time.

Outputs of the Company's principal basic products have been:

	1951	1957	1958	1959
Steel ingots	2,103,000	2,855,000	2,708,000	2,597,000
Pig iron	1,091,000	1,748,000	1,690,000	1,757,000
Coke	1,188,000	1,592,000	1,528,000	1,591,000
Iron ore	3,403,000	4,868,000	4,718,000	5,207,000

The financial statement of employment of capital shows the growth of the company's business. Fixed Assets and Trade Investments are approximately 2¾ times greater than they were in 1951 and the capital employed is more than three times greater.

Iron and steel companies use a lot of capital in the installation of plant, but even when it has been installed it is inevitable that apart from maintenance, which in any case is very heavy, special expenditure is needed to keep in step with developments and improvements. Such expenditure in this peculiar industry can hardly be regarded as capital expenditure; it needs to be provided to keep the industry alive.

The activities that I have described in my story about steel will cost money, but they will be spread over a few years and we do not expect that they will unduly burden our financial resources. They are an example of what I mean when I say steel companies have to spend large sums of money to keep themselves alive.

In conclusion, we would like to thank our fellow shareholders for the support which they have given us in the past, and we would like to think that they will welcome and commend the actions which we are taking in this present time of rapid change.

Companies

Asbestos Competition from Russia

Turner and Newall, the asbestos manufacturing group, report that with the exception of the higher grade fibres used in the textile section of the asbestos industry, demand for raw asbestos has substantially recovered from the low level of a year ago.

The more competitive trading conditions mentioned in the company's 40th annual report and accounts, clipped the group's profit before taxation from the £13,188,000 of 1958 to £13,004,000, but since the lower rate of income tax, and allowance for over-provision in previous years, took £5,639,000 instead of £6,983,000, as in 1958, the profit after taxation increased more than £1 million to £7,365,000. The recovery in the demand brought the company back in full to its normal rate of production by July of last year.

The increase in competition in Europe from Russia must affect the outlook, especially in the textile fibre range, says Mr. R. G. Soothill, the chairman, in his statement. The Russian activities mean that, although mining and milling operations are now once more back to economic performance, the earning capacity of the African mines, which are those of the group directly affected, are likely to remain at a somewhat lower level than over recent years.

The Canadian company, Bell Asbestos Mines, has been much less affected by these difficulties, than the African mines and had a very good year. In the second half of the financial year the reduced demand picked up. Subject to the same reservation about the textile grades a high and profitable level of operations from Bell Asbestos is expected.

On the home market a general improvement towards the autumn of last year was occurring in demand for the wide variety of technical rubber and textile asbestos products of Turner Brothers Asbestos. Substantially improved contracts for fire resisting conveyor belt were obtained from the National Coal Board although current requirements were reduced. The record export achievements of 1958 were not quite equalled, partly because in that year there had been exceptionally heavy power transmission belt orders from Russia.

In India, Asbestos Cement which makes asbestos cement building products and asbestos cement pipes is meeting a heavy demand. Mr. Soothill foresees a prosperous future for this company, "for so long as the Indian Government can satisfactorily solve its current financial problems."

The group also has subsidiaries functioning in Rhodesia and Nyasaland, South Africa and Brazil.

Holman Group Expands

Rapid expansion of their business in the Midlands has made it necessary for the Holman Group to provide additional sales and service facilities there, and branch premises have been opened at Lightning Way, Alvechurch Road, Birmingham, 31. Occupying a new building, with 1,220 sq. ft of office area and 2,800 sq. ft devoted to stores and workshop purposes, the branch is the Midland centre for all the Holman Group companies, Holman Brothers Limited, Climax Rock Drill and Engineering Limited, Maxam Power Limited, Goodyear Pumps Limited and the Dustuctor Company Limited. Land is available for expansion, and the workshop building is so designed that it can be extended easily.

The intention is to carry stocks of a large variety of standard products at the Birmingham premises, and to employ a sales and service staff which will provide technical and maintenance facilities over a wide area, extending to the boundaries of older branches at Sheffield and London, and the Group head office at Camborne, Cornwall.

The Cost of Keeping Steel Modern

Owning 15·6 per cent of the United Kingdom's steelmaking capacity United Steel, in the year reviewed in its annual statement, produced 17·2 per cent of the country's output.

The United Steel Companies, the largest medium and narrow strip producers in Britain, do not directly make wide strip, which was much less affected by the 1958 recession, but they are large shareholders in John Summers, who do.

Sir Walter Benton Jones, chairman of United Steel, looked forward with confidence to future demands on his companies' capacity. This was to be expected since United Steel, at Steel, Peech and Tozer, are to spend £10 million over the next five years replacing 21 by no means antiquated open-hearth steel melting furnaces with six electric arc furnaces (ENGNG., p. 645, 18 Dec. '59). A production of more than a million tons by the present method at Steel, Peech and Tozer will be raised to 1,350,000 and substantial improvements and economies brought about. In his statement, Sir Walter said that up to now no steelworks of comparable size in the world had substituted electric steel melting for open-hearth melting by the cold metal process.

The cost of this conversion, and the value which might have been thought to still remain in the 21 open-hearth furnaces, shows the forward reaching view that has to be taken by directors of concerns of this basic importance if they are to achieve the output demanded of them by industry and to remain competitive in the world market.

Oxygen

The Steel, Peech and Tozer redevelopment carries with it an immense new demand for electricity, a demand equal to a third of all present-day Sheffield consumption. At Appleby-Frodingham United Steel has been looking at its hot metal process of making steel by conversion in furnaces of iron from the blast furnaces. The substitution of oxygen, instead of simply using air with its 20 per cent oxygen content, has so raised the need for supplies of the gas, that United Steel are building an oxygen-making plant of their own.

The group's own Ajax process has already been applied to two of the ten Appleby-Frodingham steel furnaces, increasing their production by 75 per cent and cutting fuel consumption by more than 70 per cent. The Ajax process will be applied to a third furnace this year.

These are revolutionary developments in the steel industry. Without them it might have been possible to increase output by simple enlargement of the application of old methods. By leading the steel industry in electric arc furnace installation, and with the application of its own Ajax invention, United Steel seems likely to improve on the figure of making 17 per cent of British steel, and also to be forging first class weapons for the competitive steel world of the 1960's.

Hawker Siddeley Which Way Now?

As Hawker Siddeley's chairman, Sir Thomas Sopwith, makes his annual statement, attention centres on the direction which his far flung group will now take.

For Hawker Siddeley, 1959 was a year for embracing aircraft companies despite general gloomy forecasts of the future for airframe builders, if not for aero-engine manufacturers.

In August the company made an offer to the shareholders of Folland Aircraft to buy for cash all the issued 1,550,000 ordinary shares. Acceptances have by now been received for 91 per cent and it is Hawker's intention that in time Folland's shall become a wholly-owned subsidiary.

In December came the joint Hawker Siddeley—de Havilland announcement that a merger was proposed. Its basis was one Hawker £1 ordinary share for each de Havilland £1 unit of ordinary stock, and three Hawker 5½ per cent £1 preference shares and 20*s* in cash for every four de Havilland 5¼ per cent £1 preference stock units. Hawker saw this merger as of great benefit to both organisations because, primarily, of de Havilland's civil air experience, in which the growing acceptance of the Comet and the future Airco development stand out, and their own broad experience of the military field. Both companies are deeply involved in missiles and both have overseas interests in Canada, Australia and other countries. Proposals have also been made for merging with Blackburn.

For a period it may be expected that Hawker will have some digestion to do, particularly in its own internal organisation. What the future holds is one of the most fascinating problems in British industry. Before the merger Hawkers had by relentless diversification increased that part of its activities not dependent on the air markets of the world to 75 per cent. The absorption of de Havilland will have substantially increased the aeronautical proportion.

If the group now has the size to compete with the American air industry in the future production of airliners of Mach 3 speeds, then its future could outshine the past of its distinguished constituents. But a more likely outcome is that all the financial and industrial strength of the Hawker empire will make possible the more rapid bringing into the market of the three jet-engined Airco airliner, an air transport seen by some as an ultimate development for the medium range.

Success in timing here could perhaps give the Hawker group an aircraft as saleable and as durable as the Dakota.

All of which leaves unanswered the question, what will Sir Thomas Sopwith and his fellow directors decide to do about those other companies in the Airco project, Fairey Aviation and Hunting Aircraft? Both concerns are closely involved, through the Aircraft Manufacturing Company, with the DH121, so closely that their eventual arrival in the Hawker empire has already been the subject of speculation.

Firth Cleveland Back Solartron Group

Firth Cleveland, in taking control of the Solartron Electronic Group, have acquired the only firm in Britain whose growth has been so impressive as to be studied by the Harvard Business School, Edinburgh University, the London School of Economics, the Lausanne Management Development Institute and the Acton Society Trust.

Right from the start, back in 1948, Solartron avoided becoming dependent upon defence orders. Eleven years later, when its merger with the Firth Cleveland group has put £900,000 behind the advancement of its progress, Solartron has become one of the world leaders in electronic instrumentation, radar simulation, industrial controls and data processing and computation. With customers throughout the world, both industrial and Ministerial, the group's exports have expanded from £15,000 over the five early years 1949-54 to £1,181,000 in the period 1954-59. From ten enthusiasts in June 1949 the factories, now at Thames Ditton and Dorking, near London, and Farnborough in Hampshire, employ 1,330 people, a fifth of them on research.

It is the high cost of the essential development and research that has lifted Solartron to its present position in so few years that explains the present move. Considerable momentum has been gathered by the rapid expansion of Solartron and given the extra backing of the diverse Firth Cleveland group, notable success in the future seems more than likely. Solartron's chairman, Mr. L. B. Copestick, surveying the next five years, expects the present volume of sales to be expanded many times over. Deliveries in 1959-60 total £2,750,000, a 30 per cent increase on the previous year. The Solartron plant at Farnborough runs to 60,000 sq. ft and building has just begun on a 102,000 sq. ft extension to be occupied in 1961.

Research

The cost of research, the need to have highly trained sales representatives abroad, the "slowness" of certain types of the more valuable order, these are well mapped fields in electronics. What Solartron and Firth Cleveland together appear well set to do is to carry these heavy overheads on broader shoulders and to take from the brisk technical inventiveness of Solartron the brake of limited financial strength.

Standing arrangements, as between Solartron and John Brown and Company for the formation of a new company for the development of automation in warehousing and merchandising, will continue. Solartron has a number of other arrangements for technical and commercial cooperation with British and overseas companies. The Solartron group has approaching twenty companies either at home or abroad, marketing products up to an individual value of £150,000 each.

Automatic Production Lines in Russia

Automatic production lines are now used in the Soviet Union for the manufacture of many components — any one line usually being employed for the production of several similar components.

By O. Tedder

The first fully automatic factory in the world—a factory for the manufacture of automobile engine pistons—was put into operation in Russia in 1951 and extended in 1955. It now consists of two identical machine lines with a total annual output of 2·4 million pistons. Each line comprises 25 main production units which occupy a floor space of 950 sq. m. They are driven by motors giving a total power output of 953 kW. The factory was not immediately a complete success, but now it is claimed to produce the best and cheapest pistons in the country. The new features of this plant were the automation of a casting process and automatic control of weight.

The high cost of design and construction of automatic lines intended for the production of a single article called for lines which can be adapted for the manufacture of similar components of slightly varying design and size which are used in large quantities in the engineering industry, such as gears, shafts, sleeves. Lines of this type must consist of standard automatic machines or general-purpose machines linked by suitable transfer devices.

The automatic production lines for the manufacture and assembly of electric motor rotor shafts (Fig. 1) and spline shafts show how these problems were tackled and solved in Russia. The motor shaft line consists of standard machines which can be used in automatic lines as well as in normal production. It is divided into two sections by an automatic store. A rest-and-run conveyor runs in front of the machines, and the components are taken from it by single-grip transfer heads. An interesting feature is the automatic balancing unit which detects and measures the unbalance and corrects it by drilling a hole of suitable depth. In one case, the installation of such a line, enabled the machining cost of the shaft to be reduced from 6·55 to 2·56 roubles.

An automatic line for the production of spline shafts is similar in layout to that manufacturing motor shafts. The only difference is that the units for knurling the shaft and the pressing of the armature on to the shaft, and the balancing unit, are replaced by a high-output machine for the simultaneous cutting of all the splines. The yearly output of this line is 240,000 shafts and it can produce components of 13 different types. The line can be run economically on smaller batches involving between 10 and 12 retoolings per month.

The use in these lines of two-grip transfer units, with separate transfer heads for unloading and loading the work, make possible an overlapping of handling and machining operations with a resulting economy in the total cycle time.

Of about 200 automatic production lines which were operated in the USSR at the beginning of last year, 64, including several lines for the manufacture of nuts and bolts and hook chains, are run by the farming machine industry. The Altaisel'mash works operate three automatic lines: two for the manufacture of plough shares and one for mouldboards. The line producing the shares is illustrated in Fig. 2. It has an annual output of 1·1 million shares.

The line uses a special rolled section as material, and consists of the following parts: (1) cutting-off, cutting to size, and stamping; (2) machining section where three holes are countersunk, the back cut and the working surface ground; (3) bending and heat-treatment section in which the components are heated by high-frequency current and electrically tempered; (4) wet-grinding, washing and drying section; and (5) finishing and packing section, where the shares are greased and bound with wire into lots of five. The total power of the drive motors of two lines is 2,536 kW and they occupy a floor area of 864 sq. m. The reported new features of this plant include the devices for automatic grinding, heat-treatment and the handling and packing of an article of such an awkward shape as a plough share. Twelve men are needed to attend two lines. The installation of the plant has increased the productivity of labour 3·7 times and halved the production costs.

The Experimental Scientific Research Institute of Metal-Cutting Machines, which is the main Russian institution dealing with problems of automation, has also designed a number of automatic lines for the production of gears such as the change gears for a lathe, and bevel gears.

The construction of these lines intended for the manufacture of large quantities of similar articles raised the question of centralised production of these and similar components for large sections of industry. It also touches the problem of the development of an entirely new technology based on the use of automatic production lines in which the machining is reduced or eliminated altogether by the use of special close-tolerance blanks produced by precision casting, accurate rolling, drawing, or stamping.

In addition to the construction of automatic lines of the type already discussed, which are intended for the more or less complete production of a certain component; many industrial enterprises work in this field on a smaller scale combining their machines in automatic lines by linking them with transfer devices.

Much pioneering work on these lines was done by the 1GPZ, a Moscow ball-bearing factory. This factory operates seven fully automatic production lines and 20 semi-automatic lines which all consist of general-purpose machines including some automatic machines which can also be used independently. The factory claims that the commissioning of these lines and the automation of some shorter processes enabled the output of bearings to be doubled in seven years, and the productivity of labour nearly doubled, without an expansion of the floor area and with only an insignificant increase in equipment.

It is considered in Russia that, in order to increase the rate and lower the cost of automation, the development of automatic general-purpose machine tools and machine tools adaptable for use in automatic lines is called for. A need is also seen for the development of standard transportation, feeding and storage equipment for the lines, and the development of automatic sizing equipment and long-life tools.

The main obstacles to the rapid introduction of automation are considered to be the shortage of trained personnel, the usual reluctance of the leaders of Russian industrial enterprises to introduce innovations which involve for them risks not compensated by any personal advantages, and the inadequate reliability and short service life of the electrical and hydraulic automation equipment produced by the Soviet instrument industry.

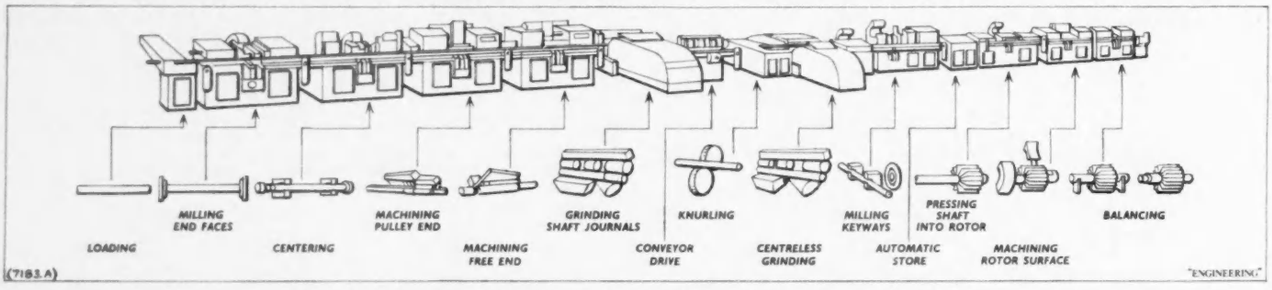


Fig. 1 Automatic machine line for the manufacture of electric motor rotor shafts.

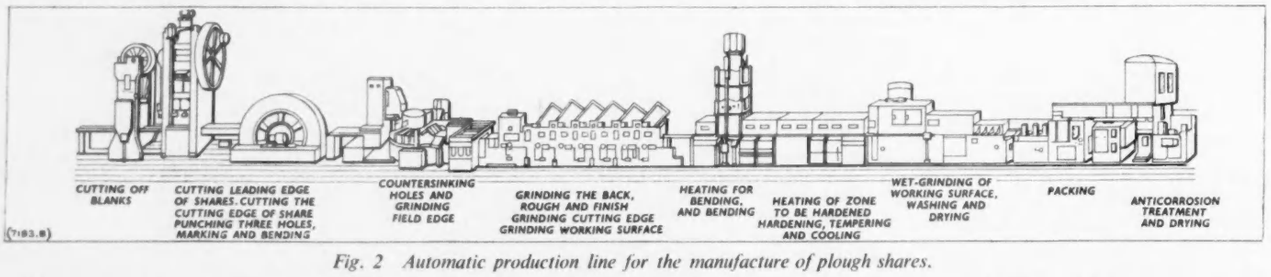
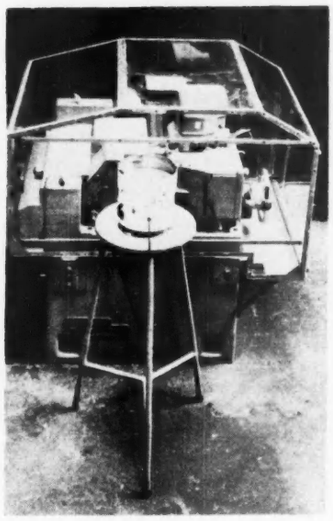

CUTTING OFF BLANKS
CUTTING LEADING EDGE OF SHARES. CUTTING THE CUTTING EDGE OF SHARE PUNCHING THREE HOLES, MARKING AND BENDING
COUNTERSINKING HOLES AND GRINDING FIELD EDGE
GRINDING THE BACK, ROUGH AND FINISH GRINDING CUTTING EDGE GRINDING WORKING SURFACE
HEATING FOR BENDING, AND BENDING
HEATING OF ZONE TO BE HARDENED HARDENING, TEMPERING AND COOLING
WET-GRINDING OF WORKING SURFACE, WASHING AND DRYING
PACKING
ANTICORROSION TREATMENT AND DRYING
(7183.B)

Fig. 2 Automatic production line for the manufacture of plough shares.

Grinding Uranium Oxide

The grinding of the materials used in the production of atomic energy, apart altogether from any question of radio activity, necessitates certain precautions on account of the toxic character of the dust produced. The usual methods of dust extraction cannot of course be wholly effective when applied to the centreless grinder due to the conditions imposed by the design of the machine, but the accompanying illustration shows one of the latest Wickman-Scrivener model O centreless grinding machines with special equipment designed by Arthur Scrivener Limited of Birmingham for this new and rapidly developing field of work.

The machine, when photographed, was set up for grinding uranium oxide slugs, and it will be seen that the equipment includes a transparent plastics hood with suitable doors to give access to the machine controls when necessary. The work is fed into the grinding throat of the machine from the small vibratory



Centreless grinding machine set up for grinding uranium oxide slugs.

hopper shown in the foreground. The grinding wheel and control wheel of the machine are respectively 12 in and 7 in in diameter. They are both 3 in wide. The main driving motor has an output of 5 h.p. (3·75 kW). On small cylindrical work of this description, the machine is reported to be capable of producing several thousand pieces an hour, a result impossible to achieve by any other method.

Port Capacity Doubled

A new mechanical ore loader has doubled the capacity of the port of Lobito, Angola. The loader, which can handle 400 tons of ore an hour, has increased the capacity of the port from two million metric tons to about three and a half million metric tons per year. The ore handled at the port is mainly manganese, the bulk of which comes from the Belgian Congo along an 837 mile railway route through Angola.

Material arrives at the port in bogie wagons with a capacity of up to 41 tons, which are overturned by a wagon tippler. The contents are deposited into a concrete hopper which is specially lined to minimise the damage that might occur from the impact of falling lumps of ore. Conveyor belts carry the ore to storage piles at a rate of 240 tons an hour.

When a ship is put on the berth for loading, the ore is reclaimed from the stocks by cranes and put on to a second conveyor belt system which is able to carry 400 tons of ore an hour to any ship lying alongside one of the eight deep-water berths at the port. The loader, built for the Portuguese harbour authorities by Spencer (Melksham) Limited of Melksham, Wiltshire, can carry out both stockpiling and ship loading operations at the same time.

More Silicon Diodes

To meet an increasing demand for the new Ferranti ZS30 series 500 mA double ended diffusion diodes, an automatic plant for their production has been put into operation by Ferranti Limited at their Gem Mill factory at Oldham. The plant is capable of producing 43,000 diodes a week or approximately 2½ million a year up to the test stage.

Until recently, most of the operations in the production of the diodes which are specially designed for automatic assembly, were carried out entirely by hand, but this was only a temporary arrangement until the new plant was installed. Study of the previous hand methods enabled the company's development engineers to break down the process into a number of simple steps. Now, all operations in the final assembly of the header, such as flash welding the wire on the back of it, passing through the hydrogen furnace to remove oxidation, are carried out by automatic transfer mechanisms. As the stages of copper and gold plating the header assembly, and that of pre-soldering the dice to the header, lend themselves well to batch production, no automatic mechanism is used for these processes.

New Board-Making Machine

A new board-making machine has recently been brought into operation by Reed Corrugated Cases Limited at their Brentford branch. The machine is over 300 ft long and incorporates the latest refinements of design in this type of equipment. It will enable the factory to increase its production by several million square feet a week.

The machine is constructed so as to give improved speed in handling materials at each end. Roller conveyors and turntables facilitate movement of the paper reels to the shaftless reel stands which have push-button controls to enable the reels to be positioned quickly and precisely. When the blanks come off the machine, electronic counters allow them to stack until a preset number is reached. They are then moved forward automatically to let the next stack form. By means of a duplex rotary cut-off, blanks of the same board quality, but of different dimensions, can be produced at the same time. This means quicker delivery of the board because different orders can, be dovetailed into the schedule for simultaneous production.

Shortly after the new machine began operating, an addition to the factory was completed, which provided the extra space needed to cope with the increased tonnage of fibreboard produced. The reorganisation made possible by this addition is reported to have speeded production and simplified handling problems.

Standardised Welding Filters

An interesting feature of BS 679 : 1959 is the inclusion of plastics as one of the materials from which filters used for viewing welding operations may be made. The choice of materials is now: wholly glass, plastics with external glass surfaces, or wholly plastics. Another change concerns requirements for refractive properties. They have been amended in accordance with the recommendations of the Ophthalmological Panel of the Ministry of Labour—thus bringing them into line with recent revisions of standards dealing with lenses for eye protection.

Besides specifying materials and refractive properties, the standard deals with quality of workmanship, optical uniformity and performance. Appendices contain detailed methods of test relating to the exposure of the filters to heat, moisture, and ultra-violet radiation. A flammability test requires the material not to burn at more than a specified rate per minute. A further modification is the discarding of " grades" of welding.

The standard uses a simplified method of identifying filters according to their shade numbers and uses only. A note explains briefly the purpose of the British Standards Institutions certification (kite-marking scheme), although in this standard use of the mark is optional.

Production Lines at School

Production lines specially built and installed at a Havant, Hampshire, school formed part of an unusual exhibition staged recently by the Plessey Company Limited of Ilford, Essex. The lines were for making switches and chokes. As well as being shown assembly lines in operation, visitors saw a display of equipment illustrating the company's activities throughout the country.

The exhibition was reported to be a great success. Over a thousand local residents went along to see it, including representatives of the local authorities. The company imagined, it would seem quite rightly, that people would welcome the opportunity of watching a production line in operation in an unusual setting. A heavy production programme prevented the company entertaining visitors actually in the factory, but the cooperation of the education authorities made the alternative possible. The company believed that " our efforts to illustrate the working conditions found in many of today's modern factories have been well worth while."

Watches with Unbreakable Springs

Samuel Fox and Company Limited, a subsidiary of the United Steel Companies Limited, have developed a new stainless alloy for the manufacture of watch and instrument springs. Known as Fortinox, the new alloy is already being used in the large scale production of stainless unbreakable mainsprings for watches and precision instruments.

Processing of the springs is done at the com-

Making watch springs.

pany's Stocksbridge works. They are made from a nickel-chromium-manganese stainless steel. The steel is semi-austenitic, and has a very high cold working factor, so that after a controlled amount of cold rolling and heat treatment, the steel has the desirable spring making properties of low notch sensitivity and high strength.

Free Piston Gas-Turbine Engines in Use

Over 3,000 hours of running time have now been logged in the first British ship to be converted to free-piston gas-turbine propulsion. She has a fuel consumption of 0·42 lb per s.h.p.-hr.

Goodwood, a 3,500 ton deadweight dry cargo ship owned by William France Fenwich and Company Limited, was converted from oil burning, reciprocating, steam machinery to free-piston gas-turbine propulsion in the early part of 1959 by Smith's Dock Company Limited, Middlesbrough. The ship sailed from the Tees in April and a total running time of just over 3,000 hours for the turbine and each of the two gasifiers has now been logged.

At the time of conversion it was decided by the owners that although Goodwood was the first British ship to be converted to this type of propulsion, no special steps would be taken to exclude her from her normal trades. It will be seen from the records of voyages completed since April that this policy has been maintained:

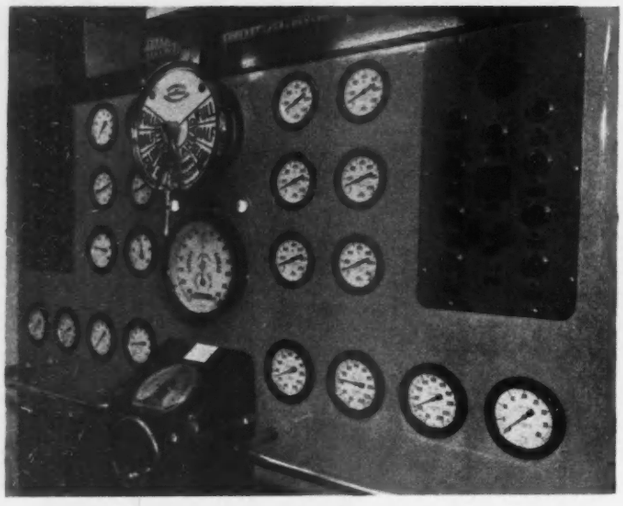
Voyage 1—Ghent to Philadelphia
" 2—Prince Edward Island to Velsen (Holland)
" 3—Archangel to Vilvorde (Belgium)
" 4—Kara Sea (Russia) to London
" 5—Kara Sea to Hull and Grimsby
" 6—Archangel to Vilvorde

To complete this programme, the vessel has encountered severe North Atlantic weather, forced ice in the Kara Sea, manoeuvred up and down the canals to Vilvorde on two occasions without damage, and encountered severe freezing on her last voyage to Archangel. It is of interest to note, and speaks well of her manoeuvring abilities, that Goodwood is one of the largest ships to have reached Vilvorde. At all times the engineers have had complete confidence in the machinery. Engine room reliability and performance have been most satisfactory, and on no occasion has the ship been without power or delayed in sailing as a result of engine trouble. The master and pilots, as soon as they have become acquainted with the characteristics of the machinery, have had no undue difficulty in manoeuvring the ship.

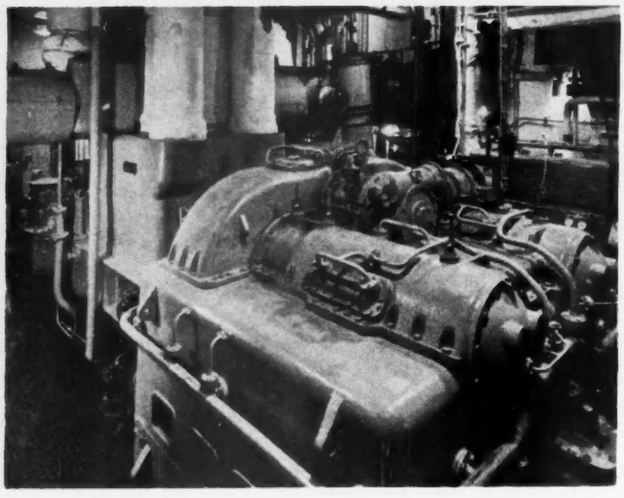
Due to the present shipping depression, it is difficult to comment on the financial results of the first eight months' operations, except to say that if the conversion had not been made, the vessel would have undoubtedly been laid up during this period, while in fact she had contributed towards her depreciation. It was not expected that any real profit margin would be obtained until the machinery was burning residual fuel. In this connection, the last voyage, Grimsby-Archangel-Vilvorde, was carried out using residual fuel of viscosity 1,000 sec Redwood 1 at 100° F.

FUEL AND LUBRICANT

Apart from a short run on 2,000 sec Redwood 1 fuel on trials, all gasifier operation during the first 2,500 hours was on marine diesel fuel, as the ship was under charter from the end of May until October, and this fuel was specified. Since then, Goodwood has operated satisfactorily for over 500 hours on 1,000 sec fuel (Redwood 1). Mobil Oil lubricants have been used throughout, and very satisfactory lubrication of the gasifier engine has been achieved so far with Mobilgard Marine 593 oil, at an oil flow rate of 3 pints per hour per gasifier.



The main panel of the Goodwood, which controls the whole installation from one central point.



A general view of the main turbine and gearbox. The air intake of the starboard gasifier can be seen in the background.

The designed performance of 0·42 lb per s.h.p.-hr at 1,700 s.h.p. has been realised. The last voyage of some 200 hours duration was carried out on 1,000 sec fuel at 1,700 s.h.p., at an average specific fuel consumption for the whole voyage of 0·418 lb per s.h.p.-hr.

PERFORMANCE

The gasifiers were built by Smith's Dock Company Limited under licence from Alan Muntz and Company Limited, and are of SEME type GS-34 design. During the first six months of operation on marine diesel fuel a gasifier stopped while at sea on three occasions, but in all cases the other gasifier was unaffected and continued running.

These stops were due to:—

	Time out of service
Manoeuvring piston fracture ..	30 hr
Fuel pump return spring failure ..	16 ,,
Fuel pump accumulator plunger seizure	3 ,,

The manoeuvring rod failure was the most serious, and no attempt was made to repair the gasifier until the ship was in port 30 hours later. Damage was found to be very slight, but later the piston synchronising linkage was removed, as the link bush had been elongated. The fuel pump return spring failure occurred shortly after the manoeuvring piston failure. Consequently, although the trouble was rapidly diagnosed, it was decided to check the linkage gear at the same time, prolonging the period for which the gasifier was out of service. A second fuel pump return spring failure within the last 500 hours was diagnosed and made good in under an hour.

In addition to the above stops, a gasifier was shut down while at sea on ten occasions to investigate and repair the following faults:—

	Time out of service
Remove insecure internal heat shield	3 hr
Repair leaking cushion release valve	12 ,,
H.p. fuel line joint leaks (6 occasions)	12 ,, (total)
Renew damaged suction valve joint washer	1 ,,
Replace cracked water inlet pipe on headplates	8 ,,

Some trouble was experienced during the first voyage from water leaks from the valve pockets in the compressor headplates, but these were replaced by headplates of a modified design after this voyage, and have given no trouble since. Inspection of the moving parts and interior of the engine after 2,500 hours has shown both gasifiers to be very clean and free from deposits.

A complete list of all new or serviced parts fitted during the first six months of operation, including those parts already mentioned, is given below:—

4 sets of fuel pump buffer spring plates
1 manoeuvring piston and coupling
1 set of piston synchronising linkage bushes
1 fuel pump return spring
4 compressor cylinder headplates (scheduled before delivery on account of design change)
2 sets fuel injector nozzles
1 cushion release valve spring
2 compressor delivery valves
1 compressor suction valve, joint washer and clamp plate
2 piston cooling oil gland rings
1 compressor headplate inlet water pipe
3 fuel pump accumulator plunger assemblies
1 fuel pump metering plunger assembly

Apart from the compressor headplates, which were scheduled for changing as a result of a

Continued on next page

design alteration introduced to overcome the problem of leakage, the total value of spares consumed as listed above was approximately £180.

Detailed information on operation during the last two months is not yet available, beyond the fact that one gasifier stopped on two occasions due to a fuel pump return spring failure and an accumulator plunger seizure. It was out of service for under one hour in each case.

WEAR

Measurements taken after 2,500 hours of operation indicate that the maximum rate of wear on the engine cylinder diameter is of the order of 0·001 in per 1,000 hours for the scavenge liner, and under 0·002 in per 1,000 hours for the exhaust liner. Maximum radial wear per 1,000 hours for the top three piston rings, ignoring wear at the ring horns, is under 0·005 in for both top rings, under 0·001 in (scavenge) and 0·002 in (exhaust) for the second ring, and about 0·004 in for both third rings. All rings have been in continuous use since the initial building of the gasifier, representing over 3,000 hours of operation for each ring to date.

The Alsthom turbine has operated satisfactorily and given no trouble at all. No maintenance or inspection has been carried out, and it is not proposed to inspect this unit until 12 months' operation has been completed. Satisfactory performance has been obtained from the Rank double-reduction gearbox since the vessel was handed over.

This is the first example of a conversion to free-piston gas-turbine propulsion to be carried out as a private venture, and it is gratifying to be able to report that, so far, the venture can be said to have been satisfactory. The engine has produced its rated output with a slightly better performance than expected, and has done this while operating on a residual fuel. Both William France Fenwich and Company Limited and Smith's Dock Company Limited are very satisfied with the performance achieved. It is also claimed that the engine room staff are enthusiastic about the installation and have confidence in the engines.

Taking the Dust out of Dustbins

Of the many and varied materials collected daily by public cleansing departments, fine dry dust, the end product after everything usable has been removed in the refuse plant, is the most difficult to handle. Automatic conversion of this end product into a sludge, for bulk disposal, is a desirable solution to the problem, but at one time this was generally thought to be impracticable. In passing, it may be remarked that the average net cost of collecting and disposing of one ton of refuse varies over the country from 30*s* to more than £3, and that the average daily yield of 1,000 persons is 15 to 18 cwt.

Dust from domestic refuse is collected and turned into a sludge.

At the Montague Street, refuse plant of the City of Birmingham Salvage Department a wet collector system for dust is now in full-scale operation. It is claimed to be the first such plant to be installed by a public cleansing authority. Built by Dallow Lambert and Company Limited Thurmaston Leicester, the plant consists of a line of 14,000 cu. ft per min wet collectors with 40 h.p. motorised fans, which deal with the dust in two stages. Abrupt changes in direction of the dust laden air cause the dust particles to be thrown on to wet surfaces, where they are held, and by using the kinetic energy of the air to create an intense spray zone, some of the very fine dust particles cling to the water droplets. The water supply is controlled automatically by electronic controls, and the sludge is withdrawn by drag link conveyors for disposal. An important feature of the installation is that a constant air flow through the exhaust hoods is maintained; this is impossible with the conventional bag type filter.

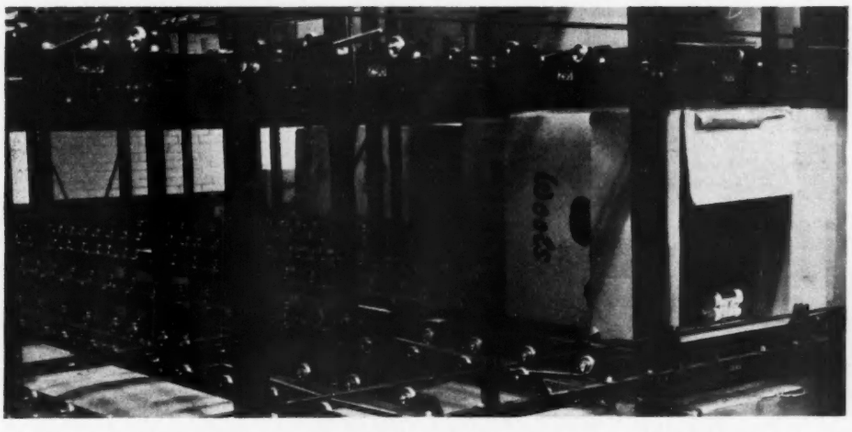
Because the dust arises at various points in the refuse plant, ducts are taken not only to the specially-designed receiving hoppers, but also to each end of the main delivery conveyor, the rotary screen and the picking belt.

Move the Goods, not the Workers

Stocking of work in progress and of finished products by the time-honoured stock bin method has several disadvantages, not the least of which are the floor space required and the amount of handling necessary. In addition, the principle of " first in, first out," which may be important with some products, such as food, is difficult to apply, and increases the handling and supervision charges.

The " live storage " system, introduced into Great Britain by the Manufacturers Equipment Company Limited, Sutton Road, Hull, provides for the storage of goods by a simple two-movement procedure; they are put in at one end of the stores, flow by gravity to the other end, and are taken out there as required. This enables the storage area to be a plain box shape, with access facilities along two faces only; all the remainder of the space is solid storage capacity. Space which would otherwise be wasted for access corridors and aisles is thus used for storage.

The basis of the system is a length of multi-wheel gravity conveyor, of a size to suit the products or the cartons, pallets or boxes in which they are held. Any required number of these conveyor tracks is built up in a steel framework to form a multiple storage rack.



" Live storage " uses gravity conveyors to reduce handling, save space and simplify stocktaking.

Unit construction of the conveyor tracks makes it possible to adapt the storage area to any size of carton, pallet or product, and the whole storage system can be built up by a user's own maintenance workers without difficulty. Sections can be added, altered or removed at any time to deal with changes in products or methods of handling or packing. Both ends of each conveyor track are always visible, and stock-taking is thus simplified.

A typical arrangement links the production and despatch departments of a manufacturer of food products. Cartons are sent by conveyor to the loading face of the storage racks and transferred at this point to the appropriate gravity conveyor tracks manually. They then gravitate through the storage area to stops at the despatch end of the storage, where they are removed in grades and quantities required to meet a customer's order. As each carton is removed another takes its place automatically and, of course, the stock is used in strict order of production. There is no possibility of items being overlooked in the stock bins.

A similar layout has been installed in the warehouse of Carter and Parker Limited, Guiseley, Leeds, for dealing with cartoned knitting wools. In this case the upper conveyor tracks are above manual handling height, and hydraulic lift trucks are used to transfer the cartons. Storage capacity is available for 500,000 lb of wool, but the space occupied is so much less than that required for the conventional bin method that former warehouse space has been made available for production machinery.

On the Shelf

By Frank H. Smith

It is high time that some journal publishers looked to their wrappers. I know most of them do all sorts of tests to devise the most efficient and strongest (within economic reason) bundle-makers for the mailed copies but they lose sight of the fact that when they bring out a bumper number to celebrate something, the wrapper might easily have to withstand double the weight or more. Quite often one receives a tattered, pathetic cover wrapped round with a piece of Post Office string and one marvels that the wrapper and its contents have stayed together long enough to be associated. One also wonders how many of those missing numbers that one has to write for have *not* stayed together with their wrappers and are still being kicked around in some remote lost packages office. There is one particular American magazine consigned to me that has its wrapper so unskilfully applied that it slips on to my desk without the need for paper knives, tearing off paper zipps or any other artifice.

When I saw a publication with the single title *Texas* I quite expected it to be all about 10 gallon hats and gushers and everything outsize. In point of fact it is the tract of Texas Instruments Limited, Dallas Road (that sounds authentic), Bedford, England. Anti-climax all round in fact. The eight pages are quite informative on instrumentation of the semi-conductor variety and it is so far up to part 2 of volume 1.

Now here's a thing. The Gale Research Company of 34th Floor, Book Tower, Detroit 26, Mich., offer me on 30 days' examination *Encyclopaedia of American Associations*, 2nd revised edition at $20, *Geographical Index* to the same at $15, *Acronyms* at $10 and *Directory of University Research Bureaus and Institutes* at $20. The first title contains 9,000 information sources (whatever that means).

The *ARS Journal* of the American Rocket Society, 20th and Northampton Streets, Easton, Pa., for November carried "Recent Advances in Ramjet Combustion"—a survey article with 81 references. Very useful, no doubt, to those interested in getting you there more quickly but there is one item in the bibliography that strikes me as being better left out. It is simply "private communication." Now what in heaven's name is the good of a reference like that in a published document? If it is intended as an appetite whetter I prefer Bristol Cream. You can at least order that.

I wish I could tell you all about *Printing Abstracts* but I can't because it is confidential to members of PATRA, although why they have to put such a note on the cover of abstracts of material that is freely published I simply do not know. It is not even as though the abstracts assess the value of the article.

Technical Information Company (Chancery House, Chancery Lane, London, WC2) will send you a folder about their "Russian Patents Gazette" translation. You must be prepared for an outlay of £20 at least.

Any house journal editor who wants to go in for the annual competition for the best should ring Roy Bell (Ha Ha—ring Roy Bell) at Fleet Street 5211, Extension 4, or write to him at 75-79 Farringdon Street, London, EC4.

E. and F. N. Spon Limited, 22 Henrietta Street, London, WC2, have a new catalogue out for January 1960.

It's all very well for the politicians to say that the Americans and we have much in common but where quite stuffy journals in this country grasped the opportunity to describe the Russians' photography of the backside of the moon, the Americans all carefully described it either as the back or as the other side. It is similar, I suppose, to their insistence on turkey and chicken having white meat and no breast. What has this to do with my column? Translation of course.

The Class of '59 Faces 1960

Directory of Opportunities for Graduates 1959. *Cornmarket Press Limited, Darley House, 1 Lower James Street, London, W1.* (8*s* 6*d*)

Directory of Opportunities for School Leavers 1959. *Cornmarket Press Limited, Darley House, 1 Lower James Street, London, W1.* (8*s* 6*d*)

Ken Jones—Electrical Engineer. By D. O. SUMMERS. *Chatto and Windus Limited, 40-42 William IV Street, London, WC2.* (8*s* 6*d*)

How to Become a Professional Engineer. By JOHN D. CONSTANCE. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (43*s*)

To the school leaver or graduate of the thirties post-war Britain has become a brave new world of unanticipated and unbridled opportunity. British industry after the war rediscovered belief in the future and zest for development. Certain branches of engineering in particular have been in the van of change. Ten years ago in 1949 the nature and the challenge of the post-war epoch were becoming defined. It was becoming clear that on the one hand greater numbers of trained and able recruits would be needed by industry if Britain were to compete with the world; and on the other, that the effect of recent Education Acts was to ease the road to university for abler schoolchildren and thus to deplete the numbers of them entering employment at 16 or 18. I argued in an article in *The Times Review of Industry* in June, 1949, that industrial companies would have to look more and more to the universities to recruit talent.

Since then comparisons have been made both with the United States and Russia revealing that Britain lagged behind in numbers of scientists and technologists trained per million of population—and even sometimes in quality of training. The relationship has been emphasised of the pace of technical change in a modern industrial state—and therefore the pace of improvement of standard of living—to the numbers of trained men produced. The larger industrial companies during these years have jostled one another in a scramble for graduate scientists and engineers; nor has any able and practical arts graduate, who has wanted to enter industry, been turned away. Thus it might seem that the *Directory of Opportunities for Graduates* is superfluous.

The obligation of making the best use of available talent remains, and always will remain for a country as dependent on the outside world as Britain. The detailed research survey undertaken by Political and Economic Planning in the middle 50's, and resulting in the publication of a very informative report on employment of graduates in industry, indicated that some firms have over-reached themselves in employment of graduates, that others have had no clear idea what they wanted the graduates to do, and that many have employed graduates on work which could have been done by less highly trained people. The scramble for technical graduates has led to many young men choosing the highest paid post on entry—or, strangely enough for a man of 22, the post with the best pension scheme—without thought of very much else. The provision of extra assistance to graduates in weighing up the relative advantage to them of the opportunities available is of value.

University appointments boards nowadays are eager to be well-informed of industrial opportunities; even Oxford discovered industry after the war. Books on careers assist them. The *Directory of Opportunities for Graduates* with its large reference section is a useful guide. The entries in the reference section are advertisements by the firms concerned, with the advantage that the information is up-to-date, but the disadvantage that the list of firms is incomplete. There were 14 additional entries beginning with A or B and seven withdrawals in 1959 compared with 1958. The publisher is able to distribute copies free to all final year students in British universities and thus to ensure that the information is brought to their notice.

The post-war births bulge will eventually during the years 1965 to 1970 mean a bulge in university numbers. This may result in a superfluity of graduates, although numbers of science and technical graduates may only become sufficient. On the other hand the average level of graduates at some universities, particularly Oxford and Cambridge which will not expand much more, will be raised because of competition for entry.

Opportunities for school leavers have improved in the last year as Britain has climbed out of industrial recession. School-leavers are fairly quickly getting placed, in spite of the bulge, although the number of apprenticeships is still far from adequate. Perhaps apprenticeship facilities are improving. The Industrial Training Council received a £70,000 grant from the Government, is showing unmistakable signs of life, and is either appointing industrial training officers or ensuring that employers' associations appoint them. But it is not clear how the industrial training officers will avoid overlapping the functions of youth employment officers which include training. The British Employers' Confederation has exhorted the member firms of its affiliated associations to take 20 per cent more apprentices. In the engineering industry the EIGA group apprenticeship scheme is expanding steadily and the Engineering and Allied Employers' National Federation is likely to give more assistance to apprenticeship groups.

Early last summer the first national exhibition on education and careers was held by the National Union of Teachers. The parents and schoolchildren who wandered around the gallery at Olympia were able to talk about conditions and prospects in a wide assortment of careers. Engineering was represented by mechanical and civil engineering stands and by a number of firms. The exhibition was well attended and if it becomes annual should become more comprehensive.

Careers books such as the *Directory of Opportunities for School Leavers*, the National Union of Teachers *Annual Guide to Careers*, or *The Times Books of Careers in Industry* need to be supplemented by personal advice. Careers master and youth employment officer can only rarely speak from first-hand experience and a visit to an engineering factory for a prospective fitter, designer or production engineer is not always feasible. A visit to a careers exhibition is often the only means of making personal contact with someone who knows the trade or profession intimately. Prestige careers advertising expenditure could with value be canalised into exhibitions.

The *Directory of Opportunities for School Leavers* is undoubtedly useful to parents and careers masters, but like its fellow volumes makes no attempt to be comprehensive. The 1959 edition includes helpful articles on "going to university" and on "opportunities for girls in industry"; the latter by Constance Arregger, herself an engineer. The reference section is larger than last year. The most valuable aspect of the directory is its large free distribution. The publisher reports that 30,000 copies have been sent free of charge to secondary schools, youth employment officers and others. The success of the directory in attracting advertisement entries shows that its service is of value to industrial companies.

Parents still seem to be bemused by the eleven plus examination, but opportunity is clear for any boy or girl with ability whether secondary education is at a modern or a grammar school. The latest of the Chatto and Windus series of career books for boys, *Ken Jones, Electrical Engineer*, tells the story of a modern secondary schoolboy, who by means of apprenticeship and technical college training becomes a professional electrical engineer. His friend, Peter Robins,

goes to a grammar secondary school, and then to university where he takes two degrees: they both become members of the Institution of Electrical Engineers and of equivalent standing in their respective firms. The book provides a great deal of detailed information on how the schoolboy gets through each of the stages to achieve professional status in a form which is more likely to be read by the school-leaver than a careers reference book. It would be an excellent fifteenth birthday present for any boy who looks to engineering for his future.

How to become a Professional Engineer is an account of the steps necessary to become a professional engineer in the United States of America. Recognition as a professional engineer depends in the USA largely on state registration, but not wholly since not all engineers are yet registered and the state regulations are not yet uniform. The main path to registration is training at a university, except for senior practical engineers of many years standing. The flexibility of the technical college route, taken by Kenneth Jones, does not exist in the USA. This book would be of great value to an engineer considering emigration to the USA and is of general interest to the British engineer.

The same kind of confusion between professional and sub-professional status of job exists in the USA as in Britain and the term " engineer " is equally widely and indiscriminately used. Thus the chapter in the American book on " criteria for evaluating experience " is pertinent to British conditions and well worth reading, and even some study, by the British engineer and engineering employer. In fact the average employer in engineering as in other industries could with advantage undertake a similar exercise in analysis of the content of the job which he has to fill and in discrimination between those jobs requiring a professional engineer or graduate and those which do not. Less misapplication of professional and graduate time would occur if this kind of analysis were more often carried out. Britain more than the United States needs to make the fullest use of her indigenous talent. The PEP survey revealed that there is room for a great deal of improvement here. Wasted time is wasted opportunity and Britain in the 1960's will not be able to afford waste of opportunities.

T. A. PRICHARD

Working to the Same Rule

Standardisation—What's In It For Me? Proceedings of the Ninth National Conference on Standards held by American Standards Association. ($4·50)

The equivalent body in the United States to the British Standards Institution is the American Standards Association. Each year the ASA organises a national conference on standards which is attended by several hundred engineers, business executives and government officials. The proceedings of the most recent of these gatherings, held in New York in November, 1958, have been assembled in this 128 page book.

The theme of the conference: " Standardisation —What's in it for me?" was a conscious attempt to present personal appraisals of the benefits which members of the ASA, notably commercial organisations, derive from the application of standards. This personal aspect was brought out in sessions addressed by some 50 speakers from executive management, research, engineering, production, distribution and retailing. The names of the speakers, many of them top-management people, are an indication of the powerful support given to standards matters in the upper strata of American business life.

While the " What's in it for me?" theme runs through all the papers contained in these proceedings, the range of individual interests covered is extremely wide. Starting with a series of ten general case-studies showing " how standards make money for my company " the conference went on to hear of more specialised applications in, for example, textiles, machine tools and electronics. Growing awareness by the Americans of the need for standardisation at the international level is apparent from the papers delivered on this subject by a number of authorities including the director of the British Standards Institution and the general secretary of the International Standards Organisation.

To what extent are non-American readers affected by the proceedings at this conference? While the standards on which so many of the case-histories are based are, of course, American, it is nevertheless true that the message which comes out of these papers is universal in its interest. Enthusiasts in Britain who require ammunition with which to convince their superiors or their fellow-directors as to the cash value of standards could do far worse than leave a copy of this booklet lying around. In view of the lack of literature on the subject, this series of papers will be useful, also, to the man who is taking the first steps towards establishing a " standards department " in his own company.

The only small point of criticism is that from the viewpoint of the outside reader (as opposed to those who took part in the conference) it would have been helpful to have had right at the beginning a short exposition of the scope and objects of the gathering.

C. DOUGLAS WOODWARD

Prospector's Lucky Dip

Economics for the Mineral Engineer. By EDMUND J. PRYOR. *Pergamon Press.* (35*s*)

Introduction to Mining. Vol. 1: Text Vol. 11: Illustrations. By BOHUSLAV STOČES. Reissue. *Pergamon Press.* (70*s*)

Economics can mean many things today, from the personal anguish of affording the new cooker to the erudite wisdom of Lord Keynes. Therefore, it is important to be clear in just what sense the word is used in the title of Mr. Pryor's new book. He interprets the word in a very wide sense indeed; in fact I think that a better title might have been " Businessmanship and Managerial Sense for the Mineral Engineer." Inevitably such a subject bears very much on financial matters, so Mr. Pryor is entitled to call it economics—just. But he goes very much further and deals with much that is in no sense economics.

We are left in no doubt as to who the book is for; it is derived from a series of lectures for students of mineral dressing, and is written in terms of commercial mineral mining and particularly of mining in developing overseas territories. It is difficult to imagine that the book will be of much use to any wider audience, since the practising engineer will, of necessity, have come to terms with most of the management problems that are raised, and would find much of the treatment trite. Nor is it likely to be of value outside the field of mineral engineering, a very great deal of it being written in the terminology and context of that very specialised field. It should perhaps be made clear that Mr. Pryor hardly includes coal mining in his subject, and the book is certainly of no more than general interest to mining students whose future lies in our own nationalised industry. But it is no crime to write for a very specialised and limited audience; it is a very commendable thing to do.

A review of this book must be in three parts since most of what Mr. Pryor writes falls into one of three categories. The first category is where he is writing on those technical subjects in which he is apparently well versed. (In technical subjects I would include such things as accounting methods.) This part of the book includes an excellent chapter on prospecting, sampling and evaluating in the field. The economic content here is the importance of the true assessment of the value of a reserve. This includes a fascinating section on the various frauds that the prospector or investor might meet. On accounting we get a straightforward and simple introduction to the basic principles of accounting procedure, which is most appropriate for the student who needs just such a non-specialist background. Much of the book consists of straight technical description of prospecting and mineral dressing. This is clearly the author's own field and he does it well. It is difficult to see how it all fits in to a textbook of economics. He does not include such technical description of underground mining operations.

The second category of Mr. Pryor's writing is on technical subjects with which he is less fully conversant. In this category we particularly notice his sections on various modern aids to management. He mentions method study and work measurement briefly, without really telling the student what they can do and how they do it. Likewise there is a pretty general and disappointingly vague piece on quality control. The importance of good routine maintenance is stressed but there is no discussion of the principle of planned preventive maintenance and the economic argument and evidence behind it. The field of operational research is given a brief mention that does it no justice. The author does not appear to appreciate the value of the application of O.R. in modern industry, for elsewhere in the book he raises problems for which there are established techniques. He raises the problem of knowing how much money to spend on prospecting and how to deploy and phase the effort; but the section does not mention the development of such ideas as search theory and games theory which may well have valuable applications. One of the most well established operational research techniques is the mathematical approach to stock control; this is not mentioned, but elsewhere the problem of deciding how much stock to hold, . . . of parts and materials, is raised. Again, we are introduced to the discussion of optimal rates of exploiting mineral reserves; Mr. Pryor clears away some of the muddled thinking that inflation brings into discussions on long-term financial policies and introduces the useful concept of present value. But such problems are an exciting prospect to the operational research worker, and of this Mr. Pryor gives no hint.

In these sections then we find this book falls rather short. A comprehensive textbook on modern management must give more than a superficial suggestion of these important aids to modern management. In most progressive organisations they are well past the trial stage

Continued on next page

and are fully established as essential parts of the system.

The third category of the contents of this book is what may loosely be called general managerial principles. Many times Mr. Pryor states ideas about how to manage men, and very sensible they are. It is most interesting to speculate how much of the practical psychology of good management it is possible to teach either in textbook form or away from the field in a lecture room. Mr. Pryor is optimistic and devotes a great deal of space to it.

Economics for the Mineral Engineer is eminently easy to read. It needs little technical knowledge, although the reader does need to understand the mineral dressing terminology (there is a 30 page glossary to help him). I would complain however that the book tries to include too much—in addition to examples already quoted it is difficult to see how a section on technical report writing falls within any interpretation of the title—and it is not well organised. For example, why is the important section on deciding best exploitation rates placed at the end of a chapter on management structures? All this leaves an impression that the work is largely a sort of omnibus of material that mineral dressing students ought to know about and which has not been covered elsewhere in their syllabus. There may be a good demand for such a gap filler.

Also from the Pergamon Press comes a reissue of Bohuslav Stočes' *Introduction to Mining*. This is a translation of a formidable Czech textbook, which is a comprehensive primer of the fundamental principles of mining and has one volume completely devoted to illustrations. Such international books have one inevitable difficulty—they cannot talk in the idiom of the individual mining industry. For example the power loaders which are described do not include many of the types known in this country. Our most widely used machine, the Anderton Shearer, is not mentioned. With this reservation it is a work of major importance.

JOHN R. LAWRENCE

New Books

Modern Engineering and Workshop Practice. Edited by W. A. TUPLIN. 4 volumes. *Odhams Press.* (185*s*)

The work of 24 contributors has been brought together under the technical editorship of Dr. Tuplin, Professor of Applied Mechanics, University of Sheffield, to form a four volume encyclopaedia of engineering practice. There are some thirty studies of various aspects of workshop practice, and the text is illustrated by nearly 1,500 line drawings and photographs. Starting logically with bench work, the first volume goes on to deal with drawing and mathematics, materials, measurement and lathe work. Volume 2 surveys welding, soldering and brazing, jigs and fixtures, toolmaking, machine tools, gear cutting and foundry work. Forging, heat treatment, sheet metalwork, plating, surface treatments, power supply, plant installation and time and motion study are dealt with in Volume 3, which concludes with a review of the factory regulations and safety requirements. Volume 4 contains 44 data sheets in a wallet, which supplement the information given in the first three volumes. A good index is vital in a work of this kind, and a test examination provided in Volume 3 for all volumes shows that it meets the requirements of the reader who wants to make a quick reference.

Worked Examples in Applied Mechanics. By W. C. DURNEY. *Pitman.* (12*s* 6*d*)

Deals with strength of materials, forces in frame structures, dynamics and hydraulics at the level of Ordinary National and Institution examinations. The book is intended as a companion volume to, not substitute for, the standard treatises. Examples from past examination papers are given.

European Refrigeration Research and its Practical Applications. *The European Productivity Agency of the Organisation for European Economic Cooperation, 2 Rue André-Pascal, Paris 16; HMSO.* (20*s*)

Report drawn up by members of EPA Mission No. 239 after inspecting laboratory work on refrigeration in several European countries. 12 countries are listed including the UK.

Advanced Mechanics of Fluids. Edited by HUNTER ROUSE. *Wiley, New York; Chapman and Hall, London.* (78*s*)

Nine authors contributed to this, including the editor who is at Iowa Institute of Hydraulic Research. Problems for solution are appended to each section and the answers given at the end of the book.

Elementary Practical Hydraulics of Flow in Pipes. By C. T. B. DONKIN. *Oxford University Press.* (21*s*)

"As a textbook its scope is restricted and treated in a sufficiently elementary fashion to make it useful for draughtsmen and others who may not have studied the science of hydraulics to an advanced standard." A particularly numerous collection of appendices with useful data.

Examples in Applied Mathematics. 2nd Edition. By F. W. KELLAWAY. *Blackie.* (7*s* 6*d*)

First published in 1946 and now fully revised. Suitable for advanced level, Ordinary National and qualifying examination of Mechanical Science Tripos (Cambridge). Sections on statics, dynamics, hydrostatics. Answers are provided.

Processing of Thermoplastic Materials. Edited by ERNEST C. BERNHARDT. *Reinhold, New York; Chapman and Hall, London.* (146*s*)

Twenty contributors from industry and universities. One of the *Plastics Engineering Series* of the Society of Plastics Engineers. 690 pages and diagrams. Three sections on fundamentals, applications, and processing properties; sub-divided into flow behaviour, heat transfer and thermodynamics, mixing and dispersing, extrusion, injection moulding, calendering, mixing and dispersing, sheet forming, forming of hollow articles, sealing and welding, and processing properties.

Introduction to the Theory of Compressible Flow. By SHIH-I PAI. *Van Nostrand.* (73*s*)

Dr. Pai's books are accepted as authoritative, coming from a research professor in fluid dynamics and applied mathematics at Maryland. This is a book demanded by students in the supersonic and faster age and is probably to compressible flow what Piercy was to aerodynamics.

Thermodynamic and Transport Properties of Gases, Liquids and Solids. *The American Society of Mechanical Engineers New York; McGraw-Hill, New York and London.* (97*s*)

Papers presented at the Symposium on Thermal Properties and sponsored by the Standing Committee on Thermophysical Properties of the ASME Heat Transfer Division held at Purdue University in February, 1959. Forty-two papers are listed in nine specialists sections. Each paper has a massive bibliography. One paper is entitled "Systems and procedures developed for the search, coding and mechanised processing of bibliographic information on thermophysical properties." It would seem a much-needed paper.

Dimensional Control in Precision Manufacturing. By JOHN L. GADZALA. *McGraw-Hill.* (58*s*)

Modern production methods and the demand for larger quantities of precision-made products require more than the old and simple draughtsman-production worker team can provide. Process, planning or methods engineering—three variants of the same theme—enter into the production scheme today, and the process engineer has to plan the most economic method of production for the products designed by the draughtsman. This book shows, by a step-by-step process, how work can be planned to meet the tolerances specified, in the quantities required.

Steel Curtain. By DAVID MURRAY. *Pall Mall Press.* (16*s* 6*d*)

Written for the general reader, this is a lightweight, non-technical survey of the whole of the iron and steel industry, from the earliest records to the present day. In its treatment of more modern times, particularly of such subjects as rationalisation, political events, nationalisation, denationalisation, and the present structure of the trade, the book gives a fair picture of a great industry, with which the whole commerce of the nation is inextricably linked. It is a pity that the treatment of the earlier history of the industry is not equally correct. Some of the dates are inaccurate, and the interpretation of historical facts is not always beyond criticism. If the reader wants a simple idea of what the industry is and does the book will help him, but if he seeks enlightenment on its history it will not.

Electronic Circuit Theory. By HENRY J. ZIMMERMANN and S. J. MASON. *John Wiley, New York; Chapman and Hall, London.* (86*s*)

With its sub-title, "Devices, Models and Circuits," this book indicates that it will be many years before saturation point is reached for books on electronics. Here "special attention is given to piecewise-linear models suitable for large-signal operation." Three appendices give transistor, triode and pentode curves. The book results from the electrical engineering course at MIT recently revised.

The Reviewers

Mr. T. A. Prichard, M.A. (Oxon.), F.R. Stat. Soc., is a management consultant in the firm, Industrial Administration Limited. He has previously been on the staff of *The Times Review of Industry*, *The Economist*, and the British Productivity Council. In 1953 he went to the United States of America as joint secretary of the productivity team on "industrial engineering." He has also visited industrial and educational units in western Europe. In the field of education Mr. Prichard holds an Oxford Diploma, has been an external lecturer of London University and has lectured in management subjects at Acton technical college.

Mr. C. Douglas Woodward is public relations officer of the British Standards Institution and editor of *BSI News*. He was previously a journalist specialising in industrial topics.

Dr. John R. Lawrence is a member of the operational research group serving the National Coal Board. He holds a B.Sc.(Eng.) and a Ph.D., having specialised in civil engineering, and is a member of the Operational Research Society.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electrical

Heating. HEATRAE LTD., Norwich. Water heaters; air heaters; immersion heaters; hot plates; fires, etc. General catalogue.

Cables. W. T. HENLEY'S TELEGRAPH WORKS CO. LTD., 51-53 Hatton Garden, London, EC1. "General information" on cables, their sizes, ratings, composition and insulation. New edition contains a section on plastics insulation. Handbook.

Speed Control. LAURENCE, SCOTT & ELECTROMOTORS LTD., Norwich. The Asmag automatic control system for N-S variable speed motors. Diagrams and description of system. Leaflet.

Circuit Breaker. JOHNSON & PHILLIPS LTD., Charlton, London, SE7. Type PDB circuit breaker rated at 350 MVA at 11 kV. Up to 1200 A capacity. Folder.

Starters. LANCASHIRE DYNAMO NEVELIN LTD., Hurst Green, Oxted, Surrey. Direct-on-line and star-delta starters up to 100 h.p. with or without isolators. Leaflet.

Geared Motors. CROFTS (ENGINEERS) LTD., Bradford 3, Yorks. "Ritespeed" geared motor units using Brush motors from 1 to 20 h.p. with enormous range of output speeds. Illustrated leaflet.

Master Controller. ALLEN WEST & CO. LTD., Brighton 7. Plug-in master controller units for cranes, coke ovens, or rolling mills. Single lever to control one or two motions. Leaflets.

Control Gear. GWB FURNACES LTD., P.O. Box 4, Dibdale Works, Dudley, Worcs. Alternating and direct current contactors and isolators for currents up to 1,400 A, 550 V. Three leaflets.

Switches. MK ELECTRIC LTD., Wakefield Street, Edmonton, London, N18. Range of 20A switches primarily designed for controlling water heating installations. Leaflet 249.

Transformers. STANDARD TELEPHONES & CABLES LTD., Edinburgh Way, Harlow, Essex. Transformers and chokes rated from 5 to 750 VA at 50 cycles. Open type. Leaflet.

Lightweight Boom of Honeycomb Construction

When radar aerials are large and exposed to high winds, they need regular inspection and so it may be necessary to construct for this purpose access equipment, which must, of course, be stable. The equipment in the case of one aerial built for the Royal Radar Establishment has to traverse the profile of the aerial up to a height of about 60 ft from the ground. It was designed and manufactured by John Curran Limited, Curran Road, Cardiff.

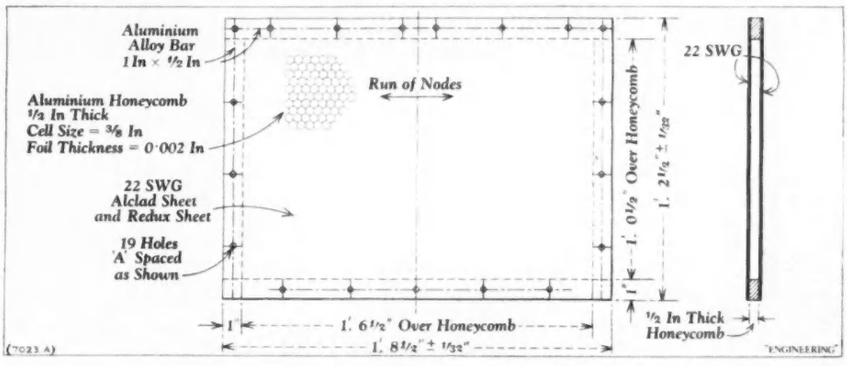
Twin towers, about 30 ft high (Fig. 3) are built of lattice steel construction and at the top of these a boom is pivoted. The effective length of the boom can be increased by a trolley extension sliding on the top face of the boom (Fig. 2). At the end of the trolley a cage is hung from which measurement of the aerial is carried out. The boom is counterpoised by concrete weights in the two towers, and the motors moving the boom and trolley can be controlled either from the ground or from the cage.

Since the whole structure had to be rigid and as light as possible, it was decided to make the boom and trolley of honeycomb-sandwich structure. For this purpose, panels using Aeroweb honeycomb core were made up by CIBA (ARL) Limited, Duxford, Cambridge.

The boom, which is 2 ft wide and tapers in depth from 2 ft 10 in to 1 ft 9 in, is of box-shaped construction with a channel on its upper surface to take the trolley mechanism. It is made up of honeycomb-sandwich panels and further strengthened by honeycomb panels set in as bulkheads. Each panel consists of $\frac{3}{4}$ in thick honeycomb bonded by means of Redux film CR between Alclad sheets of 20 s.w.g. The honeycomb material has a cell size of $\frac{3}{8}$ in with a foil thickness of 0·002 in. The edges of the panels are finished by using aluminium alloy bar which also serves for the attachment of the L and T-section alloy pieces by which the structure is assembled. In the channel at the top the 6 in flanged wheels of the trolley run on aluminium alloy strips (see Fig. 1 for panel details).

The trolley is parallel-sided and approximately square in section (15 in deep by $13\frac{7}{8}$ in wide), also made up of these honeycomb panels. The core material has the same foil thickness and cell size, but it is $\frac{1}{2}$ in thick and bonded to Alclad sheets of 22 s.w.g.

By using honeycomb-sandwich construction to keep the weight of the boom and trolley down, it was possible to economise in the rest of the structure. Although the boom and trolley have a total reach of 35 ft from the top of the towers, the driving mechanism is smaller than would have been needed with a conventional steel structure, and operates through a counter-balance arm only 18 in long. The honeycomb structure also gives the equipment the necessary rigidity, a particularly important feature.


Aluminium Alloy Bar 1 In × ½ In
Aluminium Honeycomb ½ In Thick Cell Size = ⅜ In Foil Thickness = 0·002 In
22 SWG Alclad Sheet and Redux Sheet
19 Holes 'A' Spaced as Shown
Run of Nodes
22 SWG
1′ 0½″ Over Honeycomb
1′ 2½″ ± 1/32″
½ In Thick Honeycomb
1″
1′ 6½″ Over Honeycomb
1′ 8½″ ± 1/32″
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"ENGINEERING"

Fig. 1 (Above) Details of typical bulkhead panel.

Fig. 2 (Left) The trolley extension and cage.

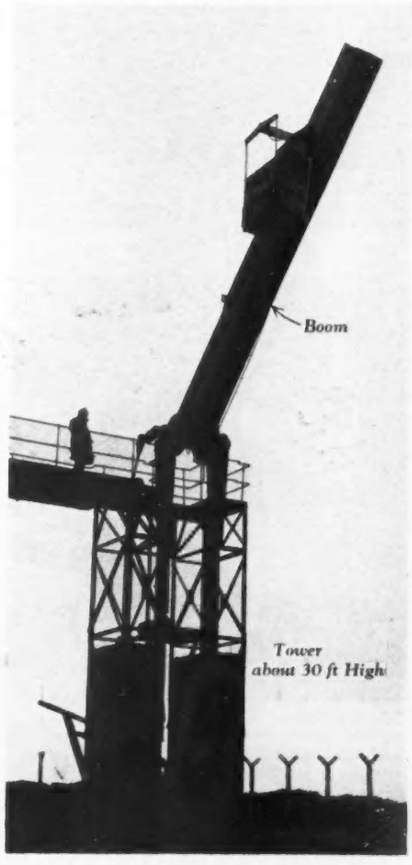


Fig. 3 (Right) One of the twin towers.

Combined Drawing Aid and Pantograph

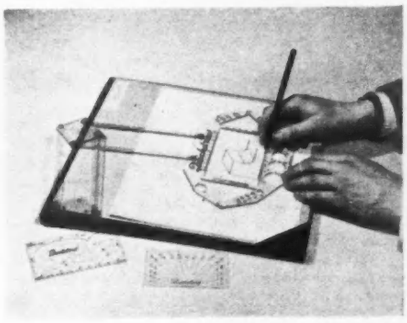
Drawings and sketches will now be easier with a device called "Quickdraw" made by the Quickdraw Company Limited, 127 Gunnersbury Avenue, London, W3.

It consists of a transparent template, bevel edged, to produce the principal angles, triangles, rectangles and so on. It is calibrated in inches and millimetres and the scaling is in $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{10}$ in. It will also produce circles from $\frac{1}{8}$ to 1 in diameter or sections thereof. These are slightly larger than size to allow for the pencil point. By placing a ruler against any edge, hatching can be neatly and quickly undertaken by the set of nine holes on the left.

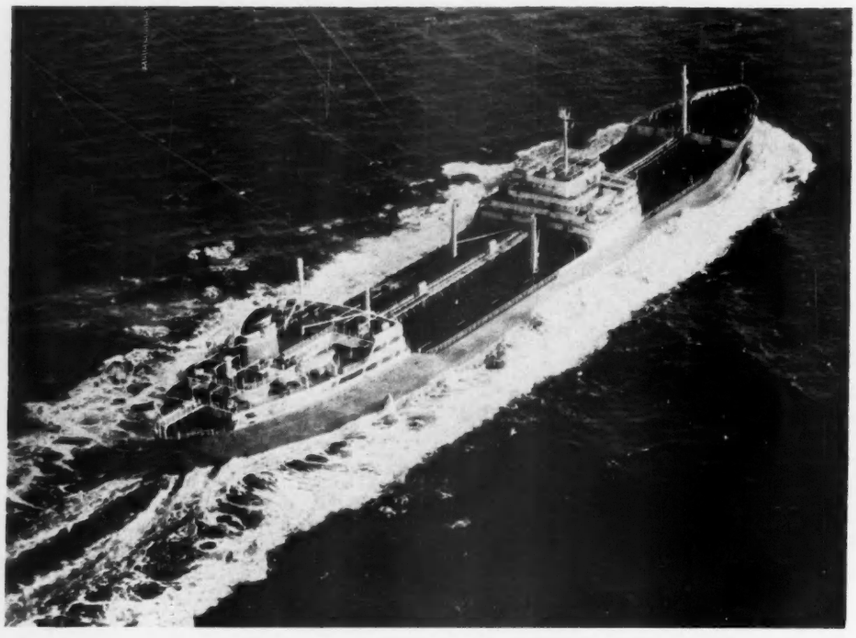
The template is fastened to a toggle hinge by strong metal eyelets, which prevent any possible slackness or sideplay, to form a pantograph. The whole is securely fixed to the base of the folder. The pantograph can be removed and fitted on any suitable board.

The folder is 14 in square and covered with strong rexine leather cloth. The base is $\frac{5}{16}$ in thick and serves as a drawing board. Corners are provided to hold the paper in position and only one drawing pin is required to hold the paper rigid. The lid of the folder is fitted with a pocket to hold spare paper, sketches, and so on. The total weight of the instrument and folder is only 2 lb and the maximum paper size 10 in by 13 in.

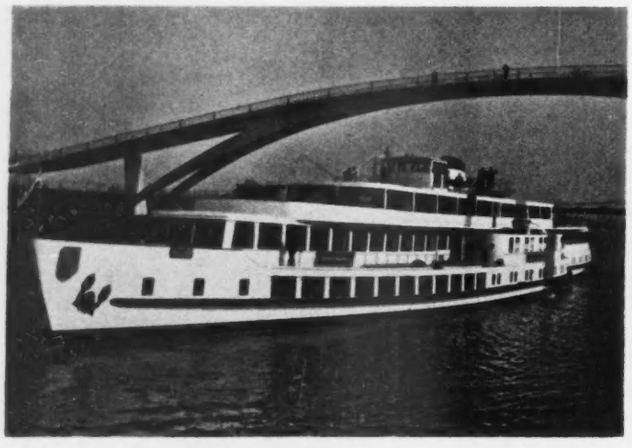
Another useful drawing help from the same company is the method symbols stencil.



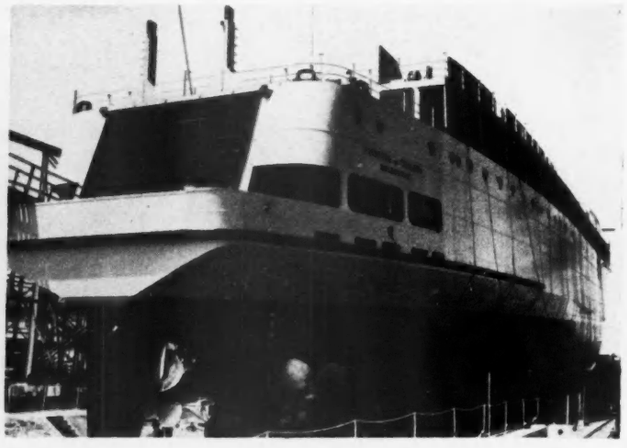
Launch of motor trawler Winmarleigh, one of three trawlers being built by Vosper Limited.



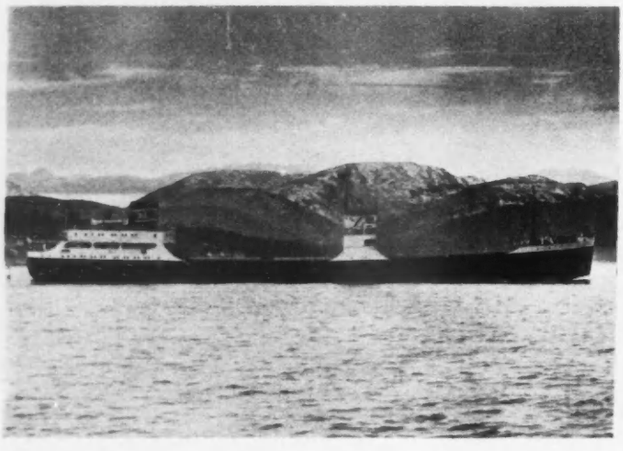
42,000 ton oil tanker, British Destiny, on her North Sea trials. Launched in March last, she was built by Swan, Hunter and Wigham Richardson Ltd for BP Tanker Co. Ltd. Design speed is 16 knots.



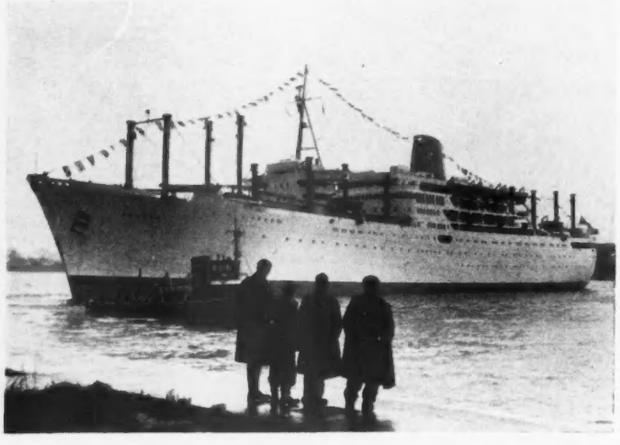
Last summer the motorship Berlin, built by Ewald Berninghaus, entered the express service between Cologne and Mainz. It has cycloidal propulsion.



Designed and built by the Australian Shipbuilding Board, this overnight ferry, the Princess of Tasmania, can carry 334 passengers and 120 cars.



The first new British ship to have free-piston exhaust gas-turbines, the TV Morar, built by Lithgows Limited for Scottish Ore Carriers Limited.



RMS Amazon, the twin-screw diesel passenger and cargo liner built by Harland and Wolff for service by Royal Mail Lines to South America.

Marketing

Taking the Amory Medicine

Price cuts in industrial materials and products continue as a steady trickle. Whether the exhortations from Mr. Heathcoat Amory, Chancellor of the Exchequer, will turn general price reductions into a river is perhaps doubtful while retail price maintenance remains in its present strengthened form.

Shell and Imperial Chemical Industries have both carried through reductions. Shell Chemical have dropped by 10 per cent the price of propylene oxide and polyethylene glycols, both of which are products with a wide use in numbers of chemicals and other materials.

ICI estimate that their cuts, on a number of organic and inorganic chemical products will save the consumer in the United Kingdom approaching £2 million a year. Solvents used in plastics processes, some explosives accessories, some chlorine products and sodium persalts are on the ICI list.

The glass making company James A. Jobling, of Sunderland, has made a thorough revision of its price list. Almost 1,200 of its 1,300 items come down by between 5 and 35 per cent. The average drop over the range is 10 per cent. Beakers, flasks, measuring instruments and other glass vessels in the laboratory, and tubing and glass rod used in manufacturing and processing industries, among them brewing, food, chemicals, textiles and plastics, are all reduced.

Benefits

Mr. John Cochrane, managing director of Jobling, explained: " We are able to pass the benefits of two years' work to our customers."

The introduction of new machinery and increased manufacturing efficiency make the new prices possible. The company operates a turret chain machine automatically blowing a wide variety of glass vessels, the only one of its kind in Europe.

Under the spirited heading, " The Chancellor Can Include Us Out," Leyland Motors vociferously recall in a statement that since June 1958 they have carried out seven price cuts. The first of these was on the 7 ton Chieftain and the most recent, in November, was perhaps the most interesting. While taking £50 off the Chieftain Series II in the United Kingdom market, Leyland introduced a number of significant improvements. In their exuberant announcement, Leyland, whose combination of reduced prices and raised performance make them constantly successful abroad, are not quite fair to the Chancellor; " The Chancellor has asked for price stability —Leyland prefer price reduction," they proclaim.

Mr. Amory has specifically urged price reduction. With the roaring industrial activity of the Midlands and the South, and the isolated areas where a labour shortage is again with us, the spectre of inflation must never be far from Mr. Amory's mind. But the boom has failed to correct the less happy conditions of Scotland, Northern Ireland and parts of Wales. General restrictions in the future would only further damage these areas. Instead, Mr. Amory may change from pleading for price cuts to taking positive steps.

Sperry Marine Down Too

A price cut of about 7½ per cent for home and overseas customers announced by the Sperry Gyroscope company means a saving of between £100 and £200 on a normal comprehensive Gyro compass installation.

The company explains that one of the reasons why it is able to make this move is because orders are large enough for the equipment to pass economically through the production process in batches.

In the ten months, February-December, last year, 216 ships were fitted with Sperry equipment, three-quarters of them with Gyro compass and Gyropilot equipments. One of the most interesting new developments is the prototype fitting in the dredger Sliedrecht XI. It is the Sperry Channel Angle Indicator which gives accurate warning to the operator as he approaches a pre-set channel angle. This is a development of which a good deal more may be heard.

£400,000 Bar Mill Modernisation

The 40 year old semi-continuous bar mill of Steel, Peech and Tozer, a United Steel subsidiary, is being modernised at a cost of £400,000.

The existing line shafting from a 3,000 h.p. variable speed a.c. motor is to be replaced with a number of separate variable speed d.c. motors. The first stand of the present mill, a pinch roll, is being replaced with a modern 18 in horizontal roll stand. A new motor room will be built to house the drives to be installed.

The main contractors are the Brightside Foundry and Engineering Company of Sheffield. The electrical equipment, including motors and rectifiers, is being supplied by Associated Electrical Industries.

Ceylon Telephone Order Helps UK Firms

A £2,500,000 British Government credit has been accepted by Ceylon for the purchase of telephone equipment from the United Kingdom.

The telephone loan was proposed to the Ceylon Government after last September's Montreal Commonwealth conference at which the idea for these loans was formulated.

Since the British telephone equipment manufacturing industry is to a large degree dependent on the Post Office for orders this work for Ceylon will be welcome. Despite the increase in the rate of spending by the Post Office for 1960-61 to £97,500,000 that figure is still some £3,500,000 below the level of 1957-58.

Taylor Woodrow in India

Specially designed steel-framed prefabricated buildings are being made in Calcutta and distributed in India by Taylor Woodrow (Building Exports) Limited, the marketing member of the Arcon Group. The new buildings have been designed for Indian conditions and are made under an agreement with Stewart and Lloyds of India, whose parent firm is another member of the group.

This new development for Taylor Woodrow follows their experience with Arcon buildings, which, in the past ten years have covered 30 million sq. ft and been sold in over 100 countries. One of the buildings is used as a cathedral in French Somaliland. They also include the largest "packaged buildings" ever exported: two textile mills for Shahi, in Iran, which together cover 12 acres.

Power-Gas Contracts

Richard Thomas and Baldwins have ordered two blast furnaces, costing £4 million together, from a member of the Power-Gas group, Ashmore Benson Pease. They are for RTB's new £100 million steel strip mill near Newport (Monmouthshire) which is planned to come into production during 1963, reaching full capacity in 1965 or '66. The two furnaces will have hearth diameters of 30 ft each.

Another member of the Power-Gas group, PG Engineering, has completed the agreement for a £650,000 contract for a complete chemical plant to be erected in the USSR. The plant, which is to produce 5,000 tons of polystyrene, will have process design by BX Plastics. Both PG and BX will be sending senior engineers for the erection and commissioning stages of the plant.

The contract was arranged with Techmashimport, whose leaders were in Britain for some time at the end of 1958.

Mixed Success in the USSR Market

Vickers and Bookers, the joint company formed for the sale of sugar beet handling machinery to Russia, China and other eastern bloc countries, are to use Duncan Stewart of Glasgow as their technical division for the £8 million contract to supply two complete sugar beet factories to the Soviet Union.

Only a month before signing this contract with representatives of Techmashimport, Vickers and Bookers had secured an agreement for more than £500,000 worth of beet equipment to be made for Russia. One of the new factories will be built in the Moscow area and the other in the Ukraine. Incorporating the most recent developments in process automation, the two factories will each have a daily capacity of 5,000 tons of sugar beet.

A less happy story, for British industry, though not in terms of East-West trade, is the Soviet $30 million (£11 million) contract awarded to the United States' consortium Intertex International, to build an immense textile plant at Kalinin. The British offer, from a group of more than 20 firms, was around £6 million with five years credit, while the Intertex group has a promise of immediate payment when the plant is complete.

What appears to have swayed the Russian negotiators is the higher productivity per employee which the Americans were able to demonstrate in their plant. Since in 1958 the United States engineering industries sold only $1 million worth of machinery to Russia, this contract represents a considerable departure in Soviet-American trade.

Platt Brothers (Sales), who would have been responsible for some £2,750,000 of the machinery had the British bid succeeded, put out a statement recalling that the firm had in recent years obtained orders from Russia worth £14 million and that not all Russian orders could come to one country.

ABMTM Machine Tools and Lapointe

The important British machine tool firm, Associated British Machine Tool Makers, is to have the services of a specially formed American subsidiary for the sales and service of its products in the United States. The sales company is Lapointe Machine Company, a subsidiary of the Lapointe Machine Tool Company, of Hudson, Mass.

The ABMTM group of five firms has operated together for 40 years. They are:

the Butler Machine Tool Company, producing planing, shaping and slotting machines.

the Churchill Machine Tool Company, producing precision grinding machines.

John Lang and Sons, centre lathes, surfacing and boring lathes, " Unitrace " profiling lathes, air operated chucks.

J. Parkinson and Son (Shipley), milling machines, " Sunderland " gear planers, " Gearbur " machines for spur, helical and double-helical gears.

H. W. Ward and Company, capstan and combination turret lathes.

The Lapointe Machine Tool Company, as parent company of the new subsidiary, is to place its engineering and sales resources behind the new organisation.

Sweden Buys American

A large order for aviation communication and navigation equipment was placed recently by the Royal Swedish Air Board with the International Division of Bendix Aviation Corporation, New York. This equipment, which is described as the "Advanced-Design " 21 series, includes an automatic direction system which is an airborne radio direction finder and provides both visual and aural navigational aid facilities. Other devices include an ultra-high-frequency glide slope receiver for instrument landing, a transistorised very-high-frequency receiver for communications, a radio unit designed to receive airway signals and a transistorised airborne navigation unit.

Investing in Israel

A new investment trust, Anglo-Israel Securities has now been launched in the City by a number of institutions who are inviting the general public to subscribe additional capital. As much as possible of the funds will be invested in Israel.

The trust, which is described as a " specialised investment company," has been launched because its sponsors feel that there is an encouraging growth prospect in Israel and that the political climate is favourable to foreign investment. This kind of enterprise is, of course, of considerable interest to the British engineering industry since a large part of the capital supplied for the development of Israel has come so far from the United States.

The Technical Problems of Broadcasting

Part 2

Managing the Low Frequencies

By D. E. L. Shorter, B.Sc. (Eng.), A.M.I.E.E.,

British Broadcasting Corporation

In broadcasting, audio frequency engineering developments centre on microphones; loudspeakers and monitoring equipment; and the problem of conveying signals from studio to transmitter.

Progressive evolution in sound techniques, and in particular the special demands of the television service, have led to a continued increase in the number of types of microphone. The British Broadcasting Corporation maintains an acoustics laboratory with advanced facilities for the calibration and testing of microphones; these include an anechoic chamber shown in Fig. 1 (one of the largest of its kind in Britain), as well as two 45 ft ducts for producing plane sound waves at very low frequencies. Regular measurements are made of new commercial types of microphones as they become available.

Where no commercial microphone comes near to meeting their special requirements, the BBC has from time to time undertaken to design its own. The most notable of these developments is the commentator's " lip " ribbon microphone, which employs an ingenious artifice to prevent the transmitted speech from being drowned by surrounding noises, such as the sound of cheering crowds. The discrimination against noise is based on the fact that a microphone diaphragm exposed on both sides responds to the pressure gradient in the sound wave. This quantity increases more rapidly with diminishing distance from the sound source than does the sound pressure; a pressure-gradient microphone used at close range in noisy surroundings therefore gives a higher ratio of wanted to unwanted sound than is possible with a pressure microphone.

The increase in apparent sensitivity of a pressure-gradient microphone at close quarters varies with frequency and increases towards the bass, but the characteristics of the microphone are designed to compensate for this effect and to give a uniform overall frequency response to the wanted sound. The original model of this microphone, produced in 1937 and believed to be the first high-quality " noise-cancelling " microphone in the world, was later manufactured commercially under BBC licence, and an improved model was introduced in 1951. A commercial version, which has been produced since, is shown in Fig. 2. This microphone[1], as far as is known, is still the only one of its kind.

The familiar BBC ribbon microphone, designed in 1934, is being rapidly superseded by a smaller, more modern, type having superior technical performance, produced in the BBC's research department in 1953. The new microphone, like its predecessor, has its commercial counterpart (shown in Fig. 3), which is manufactured under licence and is in use in other broadcasting organisations; an account of its development has been given[2]. Among the unusual features of the design are the use of an internal baffle of closely woven fabric (to equalise the bass response) and the deliberate introduction of standing wave effects in the casing to offset losses at high frequencies. By these means the directional characteristics of the new microphone are held more nearly constant with frequency than was possible with the earlier model.

In the design of all sound transmission systems, it is necessary to know the maximum and minimum levels of the incoming signal and hence the maximum and minimum sound intensity to be considered. A certain amount of information on this subject has long been available in the literature, but most of it relates only to symphonic music and is in other respects not applicable to modern conditions. To obtain data for the design of the latest studio equipment, therefore, a survey of sound levels encountered in a variety of types of programme material has been carried out and the results have recently been published.[3]

PROGRAMME MONITORING

For the visual monitoring of the programme signal a new technical aid, especially applicable to television, has recently been provided in the form of a projection-type optical meter[3] for level indication. This meter is easily readable at a distance in darkness or with normal room lighting.

The BBC have a considerable interest in the development of high-quality loudspeakers for aural monitoring. Studio staff have to listen to the programme in rehearsal to enable them to decide on the best disposition of the artists and microphones in the studio and, in cases where more than one microphone is used, the proportion in which the various output signals should be mixed. In addition, the programme must be checked for possible technical faults such as distortion or high background noise. For this purpose it is the policy of the BBC, as of other broadcasting and recording organisations, to employ loudspeakers at least equal to, and preferably somewhat better than, the best on the market.

The design of a high-quality loudspeaker is a frustrating task for the engineer since the characteristics required have so far defied attempts to reduce them to a precise specification. The performance of the final product has to be assessed by ear but, unless the subjective judgement is arrived at under carefully controlled conditions, it is easy to obtain completely contra-

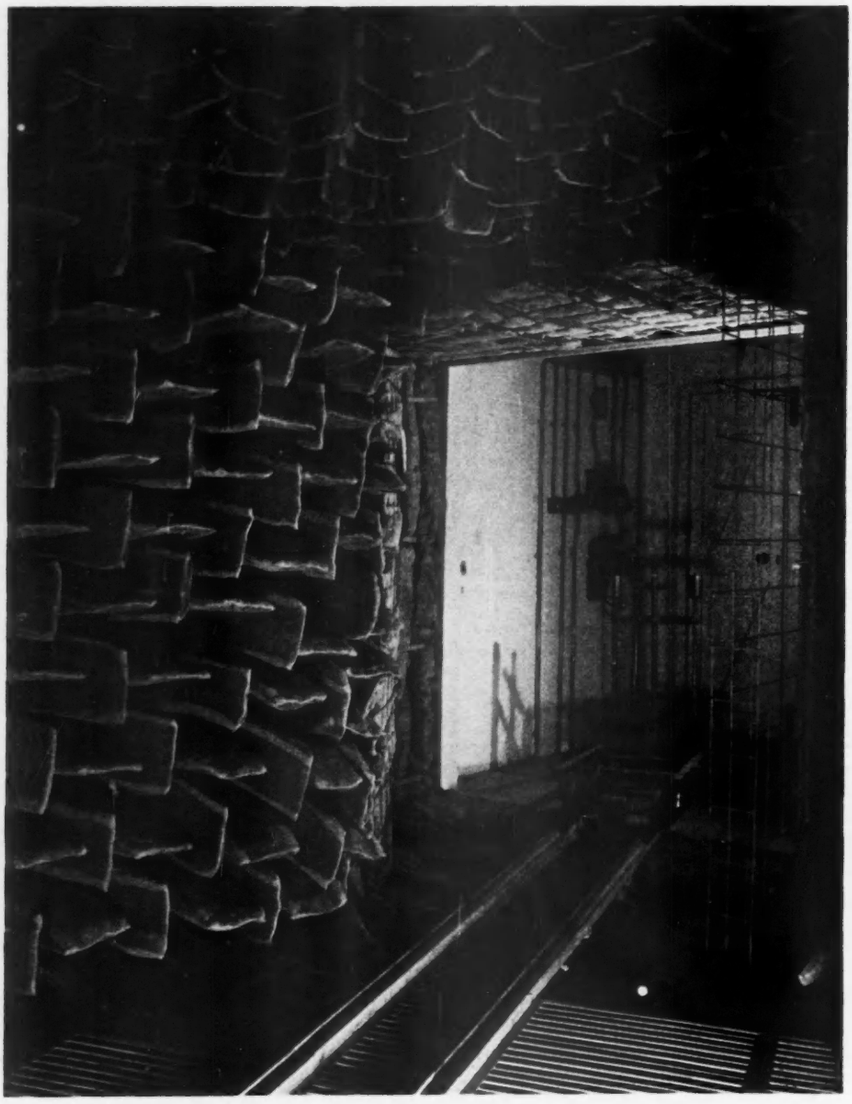


Fig. 1 Used by the acoustics laboratory of the BBC Engineering Division, this anechoic chamber is one of the largest of its kind in Britain.

Fig. 2 A commentator's microphone has to be designed to give a high ratio of wanted to unwanted sound, invaluable when used in a large crowd.

dictory results. To provide itself with loudspeakers of the necessary high standard of performance the BBC have, in addition to laboratory tests, made direct comparisons between the reproduced sound from a loudspeaker and the original sound in the studio; employing for the purpose its own trained and experienced staff. In this way, the performance of new commercial designs is rigorously assessed. The BBC also designs its own loudspeaker assemblies, by combining units from different manufacturers. Concurrently with this work, details of which have recently been given,[4] the problems of objective assessment of loudspeaker performance have been the subject of research, in the course of which some novel techniques of measurement have been evolved. These include methods of measuring and interpreting the transient response and of computing by an automatic integrating device the mean spherical response[4 5 6](analogous to the mean spherical candle power in illumination engineering). Novel equipment to facilitate the measurement of the special forms of non-linear distortion peculiar to loudspeakers has also been developed and an account of this is being prepared for publication.

Owing to the characteristics of the human ear, the impression received by a listener of the relative proportion of different types of sound—for example, those of different instruments in an orchestra—depends to a considerable degree on the level of loudness at which he hears the programme. This factor has to be taken into account by the studio staff when judging the artistic presentation of the programme as heard on the monitoring loudspeakers. To provide guidance for all concerned in this type of work, a statistical survey of the loudness preferences of various classes of listener has been undertaken, using some 200 volunteers from the public as observers.[7]

PERMISSIBLE DISTORTION

Mention has already been made of the various kinds of distortion to which an audio-frequency signal is subject. In the design of audio-frequency equipment it is important to know how far the transmission system may be allowed to depart from the ideal before the degradation in sound quality becomes apparent under given conditions. Obtaining a meaningful answer to this type of question usually involves a laborious series of subjective tests but, when the results are obtained, they are of great practical value.

One of the most interesting pieces of investigation of this kind to be undertaken by the BBC in recent years, concerns the measurement and evaluation of the amount of non-linear distortion present in a transmission chain. Empirical rules for giving the maximum allowable distortion were arrived at in the early days of the radio art, but these rules were based on the simple types of non-linearity met with in the apparatus of that period and were not always applicable to equipment such as the high-efficiency power amplifiers and transmitters that were later developed. In course of time, therefore, a situation arose in which distortion measurements could not always be taken as a guarantee of satisfactory performance unless confirmed by careful subjective tests of a kind which few laboratories can conveniently carry out. Experiments on the subjective aspect of distortion, extending over a number of years, have now borne fruit in a new method of assessing the results of a harmonic distortion test.

The conventional distortion index is based on that percentage of the power leaving the system under test which appears in the form of harmonics. The new index, however, is derived by subtracting from each percentage harmonic amplitude a fixed quantity, representing the lowest audible value; weighting the residue according to the square of the frequency; and then summing the terms arithmetically.[8] Adoption of this principle eliminates many of the anomalies formerly encountered and enables the performance of equipment to be specified with more confidence than has hitherto been possible.

Another example of a subjective study necessitated during recent years by the advance in modern standards of quality, concerns the degree of loss in the upper-frequency range that may be tolerated. A series of over 4,500 tests was carried out, with both skilled and unskilled observers, in order to determine the degree to which a listener could detect the difference between transmissions of different bandwidths. This series of experiments, because of its subjective implications became known as "Operation Cloth-ear."[9 10]

Fig. 3 The successor to the original BBC ribbon microphone is manufactured under licence, and used by other broadcasting organisations.

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Part I of these articles appeared on 1 January. Three more parts will follow at short intervals.

New Source of Electrons Discovered

In the future, radio valves themselves may become "transistorised." This apparent contradiction of terms was used by a spokesman of the Westinghouse Electric Corporation, New York, USA, when describing a new effect recently discovered by research physicists. To put it more plainly, it has been found possible to obtain a constant flow of electrons from the surface of certain semiconductor materials: therefore, if these were to be used as valve cathodes, they would be replacing the ever troublesome thermionic cathode with a cold piece of crystal that may have indefinite life.

Dr. Zener, famous for his work on solid-state reference diodes (now known as Zener diodes) said, in disclosing the new discovery, "In recent years, transistors and related devices have replaced conventional electronic tubes in a wide variety of electronic equipment. By removing the most serious limitation of the ordinary electronic tube, this discovery in semiconductors might reverse this trend and bring a new lease of life to the very device which semiconductors seem destined to outmode." In describing the new effect, Dr. Zener went on to say, "One can visualise a tube in which the usual heated cathode is replaced by a small semiconductor crystal having a built-in junction like that of a transistor. The crystal would consume a negligible amount of power and would yield electrons indefinitely when a small electric voltage is applied across it."

The semiconductor from which electron emission has been observed is silicon carbide. At the same time as emitting electrons, visible light is also emitted when the required voltage is applied to the junction. The electrons come from the same tiny spots which emit this light, the spot diameter being of the order of 50×10^{-6} in in diameter. Since currents of the order of a microamp come from these spots, the current density is comparable to that of the normal oxide coated cathode used in valves.

Atomic Energy

When M. Hirsch, president of Euratom, was in London in the middle of December he gave the *coup de grace* to any immediate prospects there may be for commercial atomic power in Western Europe outside the United Kingdom. He said that Western Europe has no need for commercial atomic power now or for many years in the future. His remarks have temporarily very seriously dampened the commercial prospects for the nuclear power industries in the United States and the United Kingdom.

The recent history of nuclear power has for industry been a classic example of the hazards which are run in translating into economic terms technical developments in a new and rapidly expanding industry. The industry has been unlucky, too, in having to bear the consequences of some highly inaccurate forecasting of electricity demand, leading not only to an overstatement of power-station requirements but also to a glut of coal.

This country is committed to a nuclear power programme of about 6,000 MW to be installed between now and 1967. By that time atomic power stations are due to be generating about 25 per cent of the country's electricity. The original programme was put together in 1955 and multiplied by three in 1957. In 1959, however, the programme was decelerated, and there is a gap of two years between the start of work on the Central Electricity Generating Board's nuclear power station at Hinkley Point and on its next station in Wales.

The costs of generating nuclear power has not fallen as fast as was expected while the cost of conventional thermal power has come down much more rapidly than anyone thought possible two years ago. The cost of constructing nuclear power stations has been adversely affected first by the rise in the long-term rate of interest and secondly by the elaborate and expensive safety precautions which have now to be estimated into current nuclear power designs following the Windscale accident. Together these add something like 20 per cent to the cost of electricity from nuclear fission and have offset useful economies on the civil engineering side.

The impact of the coal surplus and the contrary movement of capital costs can be over-dramatised. The world-wide coal and oil surplus may disappear as quickly as it came. Also, the very fact that considerable technical and economic impetus has now been built into the development of large gas-cooled reactors means that the setback of 1959 can only be temporary. The broad policy for atomic power in the UK continues as laid down, if more slowly.

Exports

Such challenge as there may be to the standard gas-cooled power reactors is developing indirectly through the marine applications of atomic energy. Last year saw the submission of eight different proposals for ship reactor systems to the Galbraith committee. Of these, only three were based on the officially approved gas-cooled system. Three others used pressurised or boiling water reactors; and one used a reactor in which an organic liquid served as coolant and moderator. A novel and promising design, compact and easily controlled by changing the moderator level, employed steam cooling and heavy-water moderation. Later, a ninth was added by a British company with access to American data on organic moderated ship reactors. There has been lively discussion about the merits of these different systems and the Admiralty itself has taken part in the controversy and thus come forward as the first Government department openly to challenge the AEA's virtually complete endorsement of gas-cooled reactors.

Beyond the immediate controversy, however, there lies the intriguing possibility of this country developing small power reactors from the marine versions, which will be eminently saleable in underdeveloped countries, where the absence of a grid system and limited power demand preclude the purchase of Britain's large gas-cooled reactors.

Britain and America appear to have reached a common position. America, once the protagonist of many systems, plans in the 1960's to concentrate her main interest on only three: the boiling, organic-moderated and gas-cooled reactors. Britain, traditionally dedicated to the gas-cooled reactor and its long-term complement the fast reactor, has now, through the ministrations of the Galbraith committee, branched out on several different paths. Why? The committee's choice has fallen on the boiling and organic systems, both alien to the British tradition, both creatures of American experience. But they are known to work. Thus, in addition to the fast reactor, which is a long term prospect, Britain has espoused three advanced systems—the same three systems that the Americans have now also chosen to develop. In confirming the Galbraith committee's choice, the Government clearly anticipate growing cooperation with America.

Manpower

The structure of the atomic energy industry in this country has been going through a series of readjustments. Formal changes were announced in July, 1959, in the Atomic Energy Authority's organisation which involved splitting up one of the groups. The Authority had been organised into three groups—Research, Weapons and the Industrial Group. This last has been split up into the Development and Engineering Group on the one hand and the Production Group on the other.

Another significant change of the year was the impact of recession on the five atomic energy consortia. Comparatively early in the year a number of the major companies in the atomic energy industry announced that participation in the development of atomic energy had involved them in heavy development costs and comparatively little profit. In the course of the year the number of consortia was reduced from 5 to 3 by the announcement of working arrangements between certain groups. The AEI—John Thompson Nuclear Energy Company have formed a joint company with the Nuclear Power Plant Company while the GEC—Simon-Carves Atomic Energy Group have made a similar agreement with Atomic Power Constructions Limited. Towards the end of the year, an arrangement between Humphries and Glasgow Limited, who had an earlier arrangement with the American company, Alco Products Incorporated, on nuclear power plants, made an agreement with Babcock and Wilcox Limited on the design and production of small capacity nuclear power stations. So far as large stations are concerned, the new associations among the consortia should ensure that all three groups have work on two power stations apiece over the next few years. Somewhere ahead, however, looms the possibility that the Central Electricity Generating Board will build its own power stations, subcontracting to specialists as it now does with conventional power stations.

In spite of the difficulties which private enterprise had in making its work in atomic energy pay, last year saw pressure being brought to bear on the AEA to give a larger amount of research and development work to private industry. The Select Committee on Estimates reporting last August on the Production and Engineering Group of the Authority said that it welcomed the Authority's intention to increase the amount of research and development work being placed with industry and thought that this kind of work could be trebled in the next few years. The Authority, though in favour of distributing research contracts, is convinced that no private organisation can possibly organise the necessary financial, technical and human resources to develop independently and from scratch a complete reactor. Euratom is another valuable source of contracts.

During 1959 an Act was passed called the "Nuclear Installations (Licensing and Insurances) Act." Its purpose is to bring atomic operators under a proposed new licensing arrangement and to make them take out insurance to cover absolute liability. Supervision will be carried out by an inspector responsible to the Ministry of Power. The longest period over which a claim can be submitted under the Act is 30 years since hurt or damage from exposure to nuclear radiation could take a long time to become apparent. Since insurance cover cannot extend for an unlimited sum over a 30 year period, owners of nuclear plant must cover themselves up to £5 million with Parliament providing sums above that amount.

Plant and Product

Although the AEA has a firm reactor policy it has not proved inflexible. The revised Zeta programme and the decision to build ICSE (which stands for Intermediate Current Stability Experiment) is an indication that the Authority is capable of reshuffling its priorities

The AEA's view is that the foreseeable future of nuclear power in this country lies with advanced forms of the gas-cooled reactor and, as a long-term development, the fast breeder reactor. Work on a prototype high-temperature gas-cooled power reactor is to proceed at Winfrith Heath as part of an international project, Dragon, jointly carried out by the European Nuclear Energy Agency of OEEC and the UKAEA. A zero-energy high-temperature gas-cooled reactor Zenith went critical just before Christmas and this reactor is expected to make an important contribution to the Dragon programme. Zenith will be used for studying reactor physics in high-temperature gas-cooled systems and operates under temperature conditions similar to those proposed for the Dragon power reactor. The HTGC system is promising as the only system, still in favour, capable of breeding fissile fuel from thorium.

An announcement was made last July that this country and the US would be undertaking a programme of underground detonations with conventional high explosives. The interest in such work is twofold. First, there is the question of detecting underground nuclear weapon trials. Second, there is the possibility of using controlled nuclear explosions in mining and other operations. During 1960 the Americans are planning to create a harbour in Alaska by this means. Such subterranean explosions may also serve in the extraction of oil, the production of heat, power and radioactive isotopes, and also in the breeding of fissile reactor fuels.

Materials

In November 1959 the Radioactive substances Bill was introduced into the House of Lords. This Bill revises the whole system of radioactive waste disposal and makes permanent a number of temporary controls. It follows closely the recommendations made by a panel of the radioactive substances advisory committee. The panel proposed that a central authority should be charged with ensuring that radioactive wastes are disposed of safely. Under the Bill the Government proposes that this control should be exercised, as it now is to a limited extent, by the Ministry of Housing and Local Government. Under the Bill all users of radioactive materials will be required to register their premises, and the Ministry will be able to impose conditions about the use of equipment on such premises. The panel also think that it may be

desirable to arrange a national disposal site. Their investigations showed that the arrangements for disposing of solid radioactive wastes are not satisfactory. According to the International Atomic Energy Agency atomic waste is building up at the rate of 11 million gallons a year.

Suitable materials are also the key to efficient nuclear power generation. With the recent commissioning of the research reactors Merlin and Nestor, materials and component testing, and also reactor-physics studies will be considerably expanded in this country.

Research

Urgency no longer dominates the atomic energy business, even in Britain. Two consequences of this breathing space will become apparent during 1960: research will be concentrated less on the detailed development of individual power stations, and more on the common problems of similar reactors; speed will give place to efficiency as the dominant requirement. No longer will it be necessary to save time by close phasing of development and construction, with research feverishly trying to keep pace.

But any departure from the singleness of purpose that has led us to concentrate on the gas-cooled reactor is likely to be short lived. The cost of fully developing a liquid-fuel reactor has been estimated by the Americans at $100 million spent over ten years, and though other systems may require a smaller investment, a diverse programme is likely to tax the resources of even the richest nation. Efficiency is likely to be pursued not by conceiving new and exotic systems, but by seeking familiar technical objectives: in particular, better heat extraction and better use of fuel.

Attempts will be made to increase the rate of heat removal per unit core volume and per unit mass of uranium. Higher fuel operating temperatures are the first step, and considerable attention will be paid to cermets and ceramics, including UC, PuC, UO_2, PuO_2 and UMo. Uranium oxide fuels have long radiation lifetime but low thermal conductivity: thus to increase the heat rating considerable subdivision of the fuel will be necessary, using clusters or compartmented fuel elements; or dispersion of the fuel in a diluent metal such as beryllium. Both approaches require higher enrichment. Even more promising are carbide fuels, which have higher thermal conductivity than oxides but suffer from swelling and cracking effects, calling for considerable development work. Choice of coolant and fuel element design also affect rate of heat removal. Future high-temperature coolants may include helium and boiling sulphur.

Equally significant in the pursuit of higher temperatures is the development of canning materials and moderators which, while offering good neutron economy, are compatible with fuel and coolant at high temperatures. Beryllium and beryllium oxide are good moderators at high temperatures, but very costly and seem unlikely at present to be economic. Graphite remains cheap and good but suffers from carbon-dioxide attack at high temperatures so that moderator cladding or helium cooling would be necessary. Continued attention will be given to the development of impermeable graphite, potentially a combined moderator and canning material. Impermeable graphite, in which the pores have been filled with further graphite or some other substance, offers efficient heat transfer and neutron economy, while containing fission products. The denser the graphite, even in conventional graphite-moderated reactors, the smaller the core may be.

A most interesting new moderator is zirconium hydride. Used so far only in the research reactor Triga, it introduces a negative temperature coefficient, so that any undue rise in temperature reduces the moderating effect and slows down the reaction, so providing automatic control. Lead plus light water has been suggested as an experimental substitute for heavy water.

Beryllium may be useful as a canning material, in gas-cooled reactors, but still remains somewhat intractable in fabrication. There is reason to believe that stainless-steel canning will be used initially in the advanced gas-cooled reactors rather than beryllium. In that case, since stainless steel is an avid neutron absorber, the question of enrichment will become extremely important, as will the development of very thin stainless-steel sections. Organic cooled systems are likely to require the fabrication of cans from sintered aluminium powder. A promising canning technique being developed at Chalk River in Canada is to fill a large sheath with uranium powder, which is then compacted by swaging the sheath.

As important as thermal efficiency is the efficient use of fuel. Two main approaches will command attention during the 1960's: the achievement of higher burnup (at present only a small fraction of the fissile content of nuclear fuel is consumed); and fuel breeding—there are 140 atoms of fertile uranium 238 to every one of fissile uranium 235 in natural uranium but the fertile component can be converted into fissile plutonium by breeding. Fissile uranium 233 may also be bred from thorium. Ceramic fuels and dust, pellet or pebble-bed fuelling are potential answers to the distortion problem, which prevents metallic fuels from achieving high burnup. The release of fission product gases creates difficulties in this connection.

Enrichment will become increasingly important in Britain. Ceramic fuels, stainless-steel canning, small reactors, higher burnups, will all call for enrichment. And, potentially, a cheap source of enrichment is just what Britain has—particularly if disarmament becomes a fact. When the big power stations come into operation (Bradwell and Berkeley are due to start up in 1961), they will produce fissile plutonium in considerable quantities. Plutonium is almost certain to be cheaper than uranium 235 produced in a diffusion plant. But it is difficult to use: being highly toxic, it is dangerous to handle and hence fabricate, and presents reactor-physics problems. Possible applications include fast reactors, thermal (moderated) breeders, thermal converters in which plutonium is used for enriching natural uranium or depleted fuel, or straight burners.

Long-range research includes the study of direct conversion fuel elements in which fission heat is transformed into electric power by thermoelectric effect. An even remoter prospect is the replacement of fission by fusion reactors. They are likely to have little significance in the 1960's, particularly now that the problems of thermonuclear plasmas have proved so formidable. On the other hand, the American decision to discontinue work on long-term fission reactors may suggest a certain optimism towards thermonuclear reactors.

Electron energy losses discovered in Zeta-type toroidal pinch machines may demand a completely new start, and in 1960 construction of the Intermediate Current Stability Experiment will represent a return to first principles. The initial objective is to understand the nature of plasmas. Practical thermonuclear devices designed to contain stable reacting plasmas may eventually follow, and finally means for usefully extracting the energy evolved.

Design

Reactor designers also have certain common objectives: thermal and neutron efficiency, fuel burnup, breeding potential, economy of fuel handling and fabrication, reliability and safety. Designers may also be concerned with compactness and the possibility of burning plutonium.

Fluid-bed concepts using gases or liquids to support the granular fuel are growing in popularity, a novel version being the Westinghouse organic-moderated fluid-bed proposal. A flowable solids reactor has also been devised, in which granular solid fuel circulates through channels in the graphite moderator. It is said to embody some of the advantages in heat removal and fuel processing of liquid-fuel reactors. Other ambitious designs include the American molten-plutonium and molten-salt fluid-fuel reactors, and a Soviet gaseous-fuel system using uranium hexafluoride. Though homogeneous reactors, which have potential fuel processing, breeding and burnup advantages, are not at present in favour, the American Homogeneous Reactor Experiment-2 has now operated for 1,600 hours (67 days) without interruption, a period comparable with the runs between servicing of any power reactor.

A very advanced project is the American Turret reactor, construction of which is to begin in 1960. The Turret reactor employs an active gas circuit—on the assumption that precautions have in any case to be taken against ruptured fuel elements. In this way the designers can dispense with fuel canning, simplify fuel fabrication and achieve higher burnup and operating temperatures (1,300° C). To simplify fuel charging, in view of the active coolant circuit, a rotating (turret) core has been adopted. The totally enclosed gas circulators incorporating gas bearings are to be supplied by a British company. The active gas circuit looks a most promising means to economic operation for HTGC reactors. Another high-temperature gas-cooled system is the Brown, Boveri—Krupp pebble-bed reactor.

To increase the efficiency of heat removal in gas-cooled reactors a gas-borne dust coolant has been proposed. Any gas-cooled system might conceivably be adapted to take advantage of this principle. A dust-fuelled reactor is also being developed in the United States.

Extremely promising but technically complex is the fast reactor, which offers potentially the most efficient method of burning plutonium. Among the more formidable tasks still to be tackled at Dounreay include a second core design to permit the transition from uranium 235 to plutonium fuel; simplification of the coolant system without sacrificing safety; and the design of machinery for fuel charging on load. With the solution of these problems the ultimate prize of burning plutonium and breeding more will be in sight.

Combined fast-thermal systems have also been proposed. Comprising two cores, one within the other, they offer to reduce the large fuel investment required for criticality in a pure fast reactor and embrace some of the safety characteristics of thermal reactors. This system may take the form of a water-evaporating outer thermal zone with direct steam superheating in the fast internal zone.

Most of the systems discussed so far have been attempts to solve goups of problems. Three particular problems are worth treating separately.

Ideally, refuelling should be continuous during reactor operation. It should also be possible to shuffle fuel within the reactor to secure maximum irradiation of each fuel element. Low and medium pressure reactors such as liquid-metal, organic and gas-cooled systems lend themselves to this purpose, but high-pressure designs such as the pressurised-water reactor do not. It is proposed that one high-temperature gas-cooled design be mounted on a railway vehicle so that, instead of changing the fuel, the entire reactor core is replaced and taken to a central depot for processing.

One of the keys to thermodynamic efficiency is an economic form of nuclear superheating. This problem may be tackled in two ways. Steam may be passed directly through a second zone of the reactor; or be heated indirectly by a high-temperature coolant such as liquid metal, an organic liquid, or gas. The United States Atomic Energy Commission predict that if direct superheat can be developed, the boiling-water reactor will win the race for cheap power in America, with the organic system close behind using indirect superheating. Nuclear superheat, direct or indirect, is essential if a nuclear power station is to compete with fossil-fuel stations. It will also permit the economy of using conventional turbine plant.

The third problem is breeding. At least as much fuel must be bred as consumed if nuclear fuel resources are to outlive fossil fuels.

Locomotives and Rolling Stock

In spite of the speeding up of the railway modernisation programme, last year saw a slight fall in the activity of locomotive builders and a more marked fall in that of rolling stock manufacturers. Nevertheless the modernisation programme is likely to assure a reasonable level of activity in the industry for the next two or three years, though it is already clear that the industry will be faced by serious problems when the programme slows down to a replacement rate, unless substantially increased export orders can be obtained.

The BTC presented their reappraisal of the Plan for the Modernisation and Re-equipment of British Railways in July last year. This re-appraisal had been set in hand at the request of the Government in the autumn of 1958 when the BTC forecast that their financial results for 1958 were likely to finish up £30 million worse than originally predicted. The reappraisal confirmed the general outline of the 1955 programme but recommended that over the next four years there should be a rapid acceleration of re-equipment and of rationalisation through the closing of uneconomic lines. In effect it recommended that the greater part of what was intended to be done by 1970 should be completed by 1963.

It was envisaged that the number of main line diesel locomotives in service would rise from about 100 at the time of the reappraisal to 2,300 by the end of 1963. Some electrification plans, such as the main line from King's Cross to Doncaster, would be delayed, the line being operated for a time by diesel traction, but others, e.g. from Euston to Birmingham, Manchester and Liverpool would be speeded up. Plans for bringing travellers to London at ever more concentrated hours cannot be pursued without some regard for the pace at which London Transport can improve its ability to carry passengers away from its underground stations at the main line termini. As regards the closing down of branch lines, the Commission closed some 300 miles of route and nearly 400 stations between 1954 and 1958; it proposed to close a further 1,800 miles of route and a proportionally large number of stations by the end of 1963.

It was envisaged that total expenditure as a result of the reappraisal would rise from £178 million in 1959 to £187 million in 1960, £200 million in 1961 and £210 million in each of the years 1962 and 1963. A large part of the increase each year will, however, be accounted for by ways and works, plant and machinery; expenditure on coaches and wagons in each of the years from 1960 to 1963 would actually be less than in 1959, while expenditure on locomotives would increase between 1959 and 1960 and thereafter remain approximately steady until 1963. Of the total expenditure from 1959 to 1963 some £265 million would be spent on electrification, £215 million on diesels (including £170 million on main line diesels, £30 million on multiple units and £15 million on shunting locomotives), £200 million on coaches and wagons, £85 million on stations, depots and marshalling yards and £65 million on track and signals. Spread over about 4½ years this would be equivalent to an annual expenditure of nearly £50 million on diesel locomotives and about £45 million on rolling stock.

Exports

The long term outlook for locomotive builders is, however, very dependent on the trend of exports. In the first nine months of 1959 the number of locomotives exported fell to 352 compared with 392 in the corresponding period of 1958, but the value rose to £7·6 million compared with £7·2 million. In 1958 steam locomotives were exported to a value of £2·5 million but in the first nine months of last year the value of such locomotives exported was only £56,000. The 1959 total was in fact composed mainly of electric locomotives (including battery types) of which exports were valued at £4·3 million, and diesel locomotives with electrical transmissions of which exports were valued at £2·6 million.

While both these categories showed a substantial increase compared with the previous year they do not yet show signs of expanding to the level necessary to ensure prosperity to locomotive builders when home orders begin to fall off. In the case of electric locomotives there has been a steady increase in exports since 1954 when the value of exports was £1·9 million. In the previous year, however, it had been £4·3 million, a figure which was only just exceeded in 1958. Exports of diesel locomotives with electric transmission have fluctuated a good deal reaching a peak of £8·2 million in 1956 and falling to only £1·8 million in 1958. The annual rate of exports of all types of locomotives in the first nine months of 1959 at £10·1 million compares with £18·6 million in 1954.

Taking all types of locomotives together the main country of destination in 1959 was the Union of South Africa to which locomotives valued at £3·7 million were exported compared with £4·7 million for the whole of 1958. Second came India to which exports were valued at £0·6 million, followed by New Zealand with £0·5 million. Exports to Rhodesia and Nyasaland which in 1958 amounted to £2·4 million fell to only £130,000 in the first nine months of 1959. Among exports to foreign countries, Robert Stephenson and Hawthorns in March, 1959, began delivery of 21 diesel electric locomotives to the Argentine. The company has supplied large numbers of steam locomotives to the Argentine but these 72 ton, 1,000 h.p. locomotives are the first diesel electrics.

As regards the outlook for exports, early last year the English Electric Company received a contract to supply 15 diesel locomotives to the Sudan valued at about £1·5 million. This order was secured in competition with 23 locomotive builders in 11 countries. The contract was financed by the World Bank which in 1958 agreed to advance $39 million for foreign expenditure under the Sudan Railways' two year development scheme. A possible threat to future exports of locomotives to South Africa was contained in the announcement that General Motors Corporation of the US has concluded an agreement with the Union Carriage and Wagon Company of Sydney, Australia, an associate of Leyland Motors, to build diesel-electric locomotives at the new Union Carriage factory at Nigel, Transvaal.

India may offer good prospects for exports of diesel locomotives if arrangements can be made to provide the necessary foreign exchange. At the beginning of last year there were 68 diesel locomotives on the broad gauge, 26 on the metre gauge and eight on the narrow gauge. Towards the end of last year, however, offers were invited from overseas manufacturers for technical collaboration in the production of electric locomotives in India. Starting with assembly of imported parts at the Chittaranjan Locomotive Works it is proposed that later all mechanical parts shall be made at Chittaranjan with electrical components being imported. Finally when the state owned Heavy Electrical Factory at Bhopal goes into production it is proposed that the locomotives shall be almost wholly manufactured within the country.

In contrast to the locomotive builders, manufacturers of rolling stock, particularly of wagons, have been short of work. The decline in freight traffic on the railways has resulted in a sharp fall in orders for wagons and the British Transport Commission have tended to allocate such work as is available to their own workshops. Even so it was announced in August that there was an immediate redundancy of about 460 employees at the Shildon Wagon Works of the NE Region of British Railways and that some redundancy was also likely to arise at other railway workshops.

Builders of passenger coaches have fared better as regards new orders due to the Transport Commission's requirements for diesel multiple units and to substantial orders from the London Transport Executive for underground rolling stock.

Exports of complete wagons and trucks showed a marked increase last year. For the first nine months of the year they were running at an annual rate of £7·5 million compared with £4·6 million in 1958. On the other hand exports of carriages and of parts for carriages and wagons fell, the former from £8·8 million to an annual rate of only £3·6 million. Total exports of carriages, wagons and parts fell from £29·4 million to an annual rate of £21·7 million.

Most rolling stock manufacturers reported intensified competition in export markets during the past year, while many countries which formerly constituted good markets are now approaching self-sufficiency. In India the output of wagons has risen from a little over 3,000 per annum to over 17,000 in two years, and the industry is now equipped to produce substantially all the requirements of the railways. In South Africa also a large proportion of the requirements of rolling stock is now made locally.

Manpower

The numbers employed in locomotive manufacture fell last year from 71,600 in September, 1958, to 70,000 in September, 1959. These employment statistics, however, no longer give a true picture of the state of activity of the industry since with the changeover from steam to diesel and electric locomotives an increasing volume of work is carried out by employees classified to other branches of engineering, e.g. electrical engineering. Although recent figures are not available it would appear that the private locomotive builders employ less than a quarter of the figures given above. In the census year 1954 the total number of operatives employed in the railway locomotive shops was 55,513 and of operatives employed by other locomotive manufacturers 14,055. The latter, however, showed a net output per person employed of £720 compared with only £527 for the railway shops. This might be construed to mean that the British Transport Commission would be well advised to buy the whole of their requirements from the private manufacturers, but the two figures are not in fact comparable since about 80 per cent of the gross output of the railway shops consists of repair work. A true comparison has never been made—much to the regret of the private builders who believe they would show up very favourably.

In the case of rolling stock the number employed on the manufacture and repair of railway carriages and wagons fell from 82,200 in September, 1958, to 76,200 in September, 1959. Here again the railway establishments account for a high proportion, the total employment (operatives and others) in 1954 being 56,707, compared with 31,052 for other establishments. The latter had a net output per person employed of £752 compared with £530 for the railway shops, but again the proportion of repairs done in the railway shops, at 57 per cent, was high.

Plant and Product

The majority of the private locomotive builders have successfully completed the heavy task of converting their plant and machinery from the production of steam locomotives to that of diesel and electric. This has involved some concentration of production and it is sad

to have to record the closure of the Forth Banks Locomotive Works, Newcastle upon Tyne, of Robert Stephenson and Hawthorns. The works, which employed 500 men, was believed to be the oldest locomotive works in the world and produced George Stephenson's " Rocket." Some of the employees have been transferred to the same company's Darlington works. The problem associated with the changeover from steam to diesel locomotives was also a major factor in the losses incurred over the last four years by North British Locomotive.

The main problem now facing British locomotive builders is whether they can make up the leeway arising from their relatively late conversion to the production of diesel and electric locomotives. While British Railways were also tardy in being converted, it should be remembered that the builders produced, and the railways used, diesels before the war, if only on a small scale.

There has recently been some free criticism regarding the multiplicity of designs of diesel locomotives which have been ordered by the British Transport Commission and also of the relatively high weight/power ratio of many British diesel locomotives, notable exceptions being the English Electric Deltic Co-Co and the Swindon built B-B diesel hydraulics. While the first point may give rise to operating and maintenance difficulties for the Commission it may prove an advantage to locomotive manufacturers to have wide experience in the early stages.

Materials

Apart from axles, tyres and wheels, locomotive manufacturers were not formerly large buyers of finished products of other branches of the engineering industry. In 1954 when steam locomotives still accounted for over two-thirds of the total output of complete locomotives by value, the industry's main purchases apart from diesel engines were steel castings, steel plates and sheets ¼ in thick and over and non-ferrous metals in all forms particularly copper and brass.

With the growth in output of diesel and electric locomotives the industry has become much more concerned with assembly, drawing diesel engines, transmission units, electric motors and control gear either from other companies or at least from other works within the same group.

The rolling stock industry on the other hand continues to be a large user of basic steel products. In 1954 one-sixth of total raw material purchases consisted of steel axles, tyres and wheels, while steel ingots, angles, sections, castings, forgings, plates, sheet and springs accounted for a further one-third. During the past year the declining output of wagons was reflected in a very marked fall in steel consumption by the industry. For the first nine months of 1959 steel deliveries to manufacturers of rolling stock other than British Railways were running at an annual rate of 176,800 tons compared with 322,400 tons in 1958 and over 500,000 tons in 1957. During 1959 the industry drew on stocks and consumption was probably well over 200,000 tons. Nevertheless, the fall is very much more marked than that in employment in the industry. The reason, of course, is that the fall in output of wagons has been much more severe than in that of passenger coaches, which use less steel, and include the new aluminium coaches for the Underground.

Research

Steam locomotives are out, so far as research is concerned in Britain today. There may be minor modifications to some locomotives on British Railways for a few years, but the Rugby testing plant, built after the Second World War when it came nearly too late to do any real good, has almost ended its short career. It is of no use for electric or diesel locomotives, which are better tested on the track.

Electric and diesel traction equipments were developed by the industry for many years before the Modernisation Plan of British Railways envisaged their large-scale extension.

There is now a joint committee for research with representatives of the BTC and the private builders. Among the projects in which they have a common interest is the development of a satisfactory commutator-less motor. The broad division of responsibility for research is that the railways study those components and characteristics for which their operating experience fits them (e.g. the relationship between vehicle and track), and the industry looks after those with which they have wider experience (e.g. the diesel engine itself). This arrangement, however, leads to certain difficulties; suspension, an important case, is referred to later.

Compared with the practice in steam locomotive days, the industry plays a much greater part in the development of locomotive design, especially since the big electrical firms have had a substantial share of the equipment orders. The industry would prefer as much as possible of the development work to be carried out by its firms, leaving the railways to concentrate on the job of providing rail transport, but the Commission is unlikely to go so far in that direction. The Commission are indeed well placed to direct much of the work, leaving the regions free to provide the public service by operating the vehicles.

For the BTC the chief difficulty with development work is that it has to be done in traffic; the only testing ground is the public service. The volume of such work is now almost at its peak, as British Railways try out a great range of locomotive types, preparatory to their major decisions for the future. Complete standardisation is a will-o'-the-wisp, but " reduction of variety " is the key policy. It will be achieved through two policies: (1) replacements of rolling stock and locomotives, always by using standard designs, which will only be changed at longish intervals, based on the results of (2) experiments with new ideas.

British Railways have had enough experience with diesel locomotives under the Modernisation Plan to know which are promising designs. Already one or two diesel engines have been eliminated from the competition. If the high cost of diesel locomotives compared with steam is to be justified, teething troubles must be minimised. The Commission thus attach great importance to designs which are fully developed and give reliable performance. The new locomotives must be good traffic machines, whatever the finer points of their construction.

Suspension design has undoubtedly suffered from the ambiguous division of responsibility between the Commission and the industry. Left to themselves, the major firms would certainly have come up with designs more sophisticated than those of British Railways, even if they had in some cases manufactured under licence from abroad. In practice the Commission have sometimes insisted on a railway design which in the end no one has liked. The trend now is to get away from axle-hung motors, using designs of flexible drive by Brown Boveri or Alsthom. The respective merits of these two designs are being compared by British Railways. But there is still much to be done on suspension design and the Commission have been aware of an ignorance of the mechanics of the relationship between vehicle and track. That lack is now being rectified by research and the official view seems to be that the time when passengers get a " good ride " is not far off.

As the Americans are said to have taken about ten years to overcome their basic dieselisation troubles, it will be a while yet before British Railways have overcome theirs. The better locomotives are already doing as much as 140,000 miles per annum—about half the potential mileage—and the 22 Deltic locomotives (3,300 h.p.) which are due to be delivered to the Eastern Region this year will be rostered at 205,000 miles per annum each. With experience accumulating at this rate it will soon be possible to determine, for example, whether the spectrographic examination of samples of engine oil is a reliable guide to engine condition.

Electrification, as the Modernisation Plan envisaged, takes much longer to get underway. Among the experimental work now in hand is that on overhead equipment. The resilient properties are being examined so as to avoid trouble with undesirable amplitudes due to wind or the passage of pantographs.

Gas-turbine traction has failed to live up to its early promise. Indifferent part-load performance was no good to British Railways. Only one of the two such locomotives is still in service with British Railways.

Design

Five standard diesel locomotive designs and two or three electric designs—that is the Commission's aim. It is not much of an oversimplification to say that the Commission dictate the mechanical design but put out a broad specification for the diesel and electric equipments against which they choose the best that the industry offers.

When the decision was taken to adopt the vacuum brake in equipping all freight vehicles, it was a decision based on the contention by the operating departments that a change over to air brakes would have been intolerably inconvenient. The fact remains that the vacuum brake will for ever impose restrictions on design and operation on British Railways.

In diesel traction the three most significant issues that will be debated for many years yet are: (1) high-speed versus low-speed engines; (2) the degree of importance to be attached to a high power/weight ratio; (3) hydraulic versus electric transmission.

On the high-speed low-speed issue it might be thought that the heavier, low-speed engine would be the more reliable of the two. In practice, British Railways have found that certain high-speed engines which have been thoroughly developed over a number of years are notably trouble free, whereas certain other engines, of the low-speed type, happen not to have been so well developed and have given serious trouble to the operating people. Both types are being given a fair trial, the Western Region, for example, tending to favour high-speed designs and the London Midland low-speed designs.

The same issue of engine speed ties in with the second issue—the power/weight ratio—since high-speed engines are low in weight. The specific weight of traction diesel engines ranges widely, from 6 to 24 lb per horsepower. But specific weight is not necessarily the most important criterion of merit in an engine. It may reduce the axle loading on the track but the Commission's engineers have to consider many other factors.

Weight is needed for adhesion, both in pulling a train (traction) and in stopping it (braking). Surprisingly little is known of the mechanics of locomotive adhesion but the Commission are doing research on the subject.

On the third issue—hydraulic versus electric transmissions—neither type shows an obvious merit over the other. Efficiencies are similar and first costs are not widely different. Both are capable of providing a good drive, but time is needed before the Commission can reach any kind of decision based on first-hand experience.

There is almost no limit to the number of diesel locomotive units that the American railways will couple together to haul exceptionally heavy trains. British Railways, like most European railways, prefer to have a suitable locomotive for each class of work. There are several good reasons for this policy, including the restricted lengths of some London termini, signalling and train control requirements.

Among the many engineering decisions which will be taken in the next few years, there can hardly be one which is wholly technical. With the builders, too, every decision must be tested against the requirements of running a railway.

Aircraft and Engines

There can have been few years in the history of the aircraft industry when it has been the subject of so much comment and advice.

Up to the beginning of December, 1959, the contraction and reorganisation of the aircraft industry appeared to be moving rather slowly. The shrinkage of the total labour force has been going a great deal more slowly than expected and was very far from reaching the estimated figure of 150,000 for which there was believed to be adequate work. In the same way the major companies of the industry have shown a marked reluctance towards the amalgamation which has been favoured by the Government for some eighteen months. During December, however, this position changed and it is now rather more possible to see what the future shape of the aircraft industry structure is likely to be. Whatever may be said about Government and airline corporation support for the aircraft industry in the home market it is obvious that the size of the industry which can maintain itself is dependent almost entirely on its success in the export market.

Exports

So far the decline in exports which is almost bound to take place has not been apparent. Exports in 1959 will probably total some £160 million or slightly above. On the first nine months' showing it is interesting to see once again the exports of engines rose very considerably while those of aircraft and parts showed for the first time in several years a slight decline. This position is unlikely to be maintained over the next two or three years.

World air traffic during 1959 resumed a more promising rate of expansion. The initial impact of cuts in defence requirements corresponded with a bad period for the airlines; 1958 passenger traffic showed an increase of only 2·3 per cent over that of 1957. During 1959, both the ending of the business recession and the introduction on an increasing scale of the big jet aircraft helped to raise the number of passengers carried up to 96 million, a figure 10 per cent higher than that of the previous year. A further factor was the growing popularity of the range of cheap fares now offered; the Economy Class fare on the North Atlantic route was already making some impact during 1958. It is confidently expected that air traffic will continue to increase at about the same rate in 1960 so that the total passengers carried will exceed 100 million for the first time.

The rise in cargo traffic was more marked than that of passengers. From 1,135 million ton miles in 1958, this was raised by 14 per cent to 1,295 million ton miles; this compares with a growth of only 2 per cent in the previous year. The International Air Transport Association believe that a further large increase is likely during 1960. The number of all cargo services will increase, and lower rates will be in operation in many instances.

A continued and fairly rapid build-up of traffic is essential to the airlines. The very narrow margin on which air transport operates is well known and the past year's results have shown that the British Corporations are by no means out of the wood. During the coming year it has been estimated that more than 200 further jet air liners will come into service, which, if a sufficiently high load factor can be achieved, are capable of greatly improving airline economics. The achievement of this load factor must remain a matter of some speculation. No general agreement on fare reduction has yet been reached, though there is widespread agreement that this is one of the main ways in which traffic and revenue can in the long run be increased.

With the build up of jet airliner deliveries, two factors are apparent. The first is that, whatever the relative economics of jet versus propeller, increasingly few airlines are prepared to risk using propeller aircraft to compete with jet aircraft. It is becoming more and more evident that even for short stage-lengths, replacements for aircraft of the Viscount size and capacity will be pure jet machines. The second factor, to some extent allied to this, is that the bottom appears to have dropped out of the secondhand market. This applied in the first instance particularly to the larger piston-engined machines; sales of the DC3 (which seems to refuse to be replaced) continued well, particularly for business conversions, and secondhand prices of Viscounts were well maintained. Recently, however, the secondhand market even for propeller-turbine aircraft has become noticeably weaker.

A special White House report, published in September, 1959, estimated that the value of surplus aircraft and parts likely to be put on the market in the three years to 1962 would amount to nearly $1,000 million. A total of 833 aircraft, 556 of them four-engined, would probably be sold by US carriers, and further aircraft will be disposed of by the US Government.

These two factors have repercussions right up to the top level. A large surplus of piston-engined aircraft is building up—aircraft which still have a great deal of useful life left in them. Their low resale value increases the difficulty of finding finance for new aircraft. At the same time, operators who wish ultimately to replace their existing Viscount fleets with jet aircraft will need a secondhand market for their Viscounts.

These considerations stress again the vital importance of timing in the aircraft industry, which has a particularly strong bearing on the present case of the British companies.

The situation has some points of resemblance to that in shipbuilding; what is needed is a pause in production to allow a surplus carrying capacity to be absorbed. Unfortunately, the resemblance ends at that point; even assuming producers can survive the slack period, it is a question of a great deal more than merely restarting production. The precise point at which the next generation of aircraft will be required by airlines is itself a difficult balance between improved running costs, large capital expenditure, estimates of the extra performance which might be obtainable by waiting two or three years longer, possible difficulty in disposing of existing fleets, and the sheer necessity in air transport of keeping up with the Jones's and staying competitive. One of the inherent difficulties of the aircraft industry is that of any producer whose output consists of large expensive units: the difference between success and failure is measured in terms of a comparatively few orders. On top of this, however, at the upper limit of size and performance progress is not a steady movement but a series of increasingly large and costly steps, the length and timing of which can be to some extent controlled. No manufacturer can opt out of this, any more than can an airline.

Disposal of the generation of jet transports now coming into service will be a tougher problem than the present difficulty in disposing of Constellations, DC6-Bs and DC-7s, which is likely to mean that the former aircraft will be kept on trunk route service for considerably longer than piston varieties. It is on the answer to this question that the success or failure of the largest current British project, the Vickers VC 10, depends.

Against this background, the supersonic airliner project must be viewed. In this field, the size of the technical step to be taken, the timing and the financial risks involved are more critical than with any project yet considered by the industry. The estimated development costs lie between £150 million and as much as £300 million. The total market has been variously estimated at not more than 150 aircraft. The possible speeds considered range from the just supersonic 800 to 900 m.p.h. at one end to 2,000 m.p.h. and in some cases higher. In between lie the projects for machines of about 1,500 m.p.h. or Mach 2.

Leaving aside the relative merits of the various proposals, the big—and vital—question remains as to whether such an aircraft should be built in Britain at all. Even in America it is assumed that a supersonic airliner would be a joint project of several companies and that there would be no room for two such machines to be built in America. There are as many grounds for doubt as to whether there is room for two designs in the international field, and in this context the Russians can no longer be ignored. Bearing in mind that the outcome could well mean virtually a total failure to obtain any markets, since it is very unlikely that any sales would be shared anything like equally between a British and American design, the argument against the project carries considerable weight.

Not to undertake a supersonic airliner might well mean yielding the trunk route market to the Americans (and the Russians?) entirely. It is at least arguable that concentration on less spectacular machines aimed at a much wider market, with much smaller financial risk, and a much larger number of units, would suit the scale of the British industry much better.

Apart from military contracts, the industry has currently on offer a number of aircraft aimed at a much less romantic and more down to earth market. These are at present struggling but gaining support, and appear to have a promising future. A striking feature is the speed with which these machines, notably the Argosy, have been designed and flown. It is projects such as these which can fill the productive capacity of the industry in the unpromising years of the immediate future.

Manpower

In the view of the Government, the aircraft industry will need to contract from its maximum employment in 1956 of nearly 260,000 to a maximum of 150,000, in addition to the concentration and regrouping of the industry forecast a year or two ago. It is interesting to see how slowly this process of contraction is in fact going on. The latest available figures for September, 1959, show a total employment of nearly 235,000. In fact it looks as though the shrinkage that has gone on so far is mainly due to natural wastage rather than outright redundancy. It is of course impossible at this stage to tell how far the maintenance of employment has been due to diversification. In addition, of course, it has always been very difficult to estimate the total number engaged in one aspect or another of aircraft manufacture either directly or indirectly. Subcontracting is carried out on such a wide scale that the forecast recession in the aircraft industry may well have affected sub-contractors fairly severely. If this is the case—and it seems likely—the direct employment in the aircraft industry may fall rather more rapidly during the next two years than has been the case hitherto.

There is no doubt, however, that for a very large number of employees in the aircraft industry redundancy is only just round the corner and has been averted during the past year only by last minute orders. The jobs of many working at Short Brothers and Harland in Belfast were saved by the order for the Britannic freighter. In general the rundown appears to have been slightly slower than that expected by the companies.

There are two aspects of this problem so far as the future is concerned. The first concerns the factory workers who will in a large number of cases require to be settled in other industries. The second concerns the possible future of technical staff of various degrees of training. Many of these no doubt can find a satisfactory future in other industries where their skills can be utilised. Many, on the other hand, may feel that despite the unpromising future for aircraft

both here and in America on balance it may be worth while emigrating in an attempt to stay in the same line of business. This could result within the next two years in a substantial drain of highly trained technical personnel away from this country.

Plant and Product

Though the total labour force has so far declined only slowly, the end of 1959 saw the beginning of the concentration of the industry favoured by the Government. The biggest move was the amalgamation of Hawker-Siddeley and de Havilland to produce one of the largest aircraft groups in the world. This in turn set off speculation as to whether further amalgamations were in the offing. Earlier, Westland had absorbed the aviation interests of Saunders Roe.

The regrouping of the industry to date has left two major competitors in the engine field. Rolls-Royce remains as before, still the largest unit. Bristol-Siddeley Engines were the first fruit of rationalisation, and with the de Havilland-Hawker merger, the resources of the de Havilland Engine Division will be at the disposal of this company.

Though such mergers will leave the industry in a much stronger position, the fact remains that there is a large and at present unfilled gap between the end of production of current aircraft and the introduction of the next generation. Design and development facilities are still likely to be occupied but production lines will be increasingly hard to fill.

This pattern is repeated in a number of companies. At Vickers, production of Viscounts is drawing to an end, Vanguard orders have been slow to come, and deliveries of the VC 10 will not start before 1963. Production of Comets at de Havilland will tail off in 1960 or 1961 and deliveries of the DH-121 will start in 1963. Short Brothers and Harland were saved by the Government order for the Britannic transport but again deliveries will not start before 1963. Orders for the Rotodyne (and for the DH-121) could affect Fairey from 1963 onwards. Both Bristol and English Electric have important guided missile contracts to occupy production facilities until the mid-1960's, but it is doubtful how far any missile contract can compensate an aircraft firm for lack of aircraft orders. English Electric are of course more fortunately placed with orders for the Lightning fighter, as also are Hawker Siddeley with production of the Vulcan bomber continuing. The next two years are thus critical and the end of this period is likely to see a radically reorganised industry.

Materials

Though aluminium alloys naturally remain the most important structural materials required by the industry, increasing speeds have laid more and more stress on less conventional materials such as titanium and stainless steel. The Bristol T-188 supersonic research aircraft has redrawn attention to the latter material in this country. Due to fly during the coming year, it incorporates a large quantity of welded stainless steel in its structure. While extensive use of this material in production aircraft is unlikely in the immediate future, it may become important within the next decade.

A more remote possibility was mentioned by Mr. Donald Douglas in a lecture in April of last year. He claimed that the replacement of steel by beryllium could reduce the weight of a 2,000 m.p.h. fighter by as much as 7 tons and increase its range by 16 per cent. He was not deterred by the non-availability of beryllium in tonnage quantities, or by its current price of around £6 per ounce.

Research

During the past ten years it has become apparent that the amount of money spent on aircraft research and development must be given an upper limit. At the same time the increasingly stringent requirements of military aircraft and the importance of the safety and reliability of civil aircraft, indicate a need for an increased research programme. These conflicting requirements make it clear that the efficacy of spending money must be increased rather than the amount changed.

This can only be done by being carefully selective. But, the selectivity should take place in the field of development rather than research. In fact, only by broadening the basic research field can a clearer indication be achieved of the development projects which are likely to succeed. Of course the field of basic research cannot be expanded indefinitely but the restrictions should be imposed more by the requirements of safety and reliability than by a desire to cut costs.

By and large, the efficacy of air transport depends on improvements in aerodynamic design, materials and propulsion systems. In the subsonic field, most of the basic research has been done and there are only a few subjects on which further research would be likely to yield worthwhile results, at least in terms of flying efficiency. In the supersonic field it is entirely different. Although supersonic flight is an everyday occurrence now, the problems of truly efficient working have only been scratched.

Research is revealing new aerodynamic shapes for supersonic flight, but further research is needed into the materials and methods of construction, in order to cope with these new shapes. In particular, the effects of the kinetic heat "barrier" may lead to a whole new design philosophy, as well as constructional changes.

Research on high speed aircraft has shown, in recent years, that efficiency of operation is not inversely proportional to speed over the entire "spectrum." In fact, on the "curve" relating increased speed to aircraft efficiency there is a whole series of "peaks" and "dips." For instance, the piston-propeller aircraft is most efficient at about 300 m.p.h., whereas the peak for turbine aircraft occurs at around 400 to 450 m.p.h. For jets the peak appears to be somewhere in the region of 600 to 650 m.p.h. Between 650 m.p.h. and 1,200 m.p.h. there is a definite trough, but, from 1,200 m.p.h. to about 2,000 m.p.h., a small peak seems to appear again.

The development of a supersonic aircraft, to fly at three times the speed of sound, is now being looked into by the International Civil Aviation Organisation, who believe that the introduction of such an aeroplane would have important consequences. It is assumed that the aeroplane would be able to travel at 2,000 m.p.h.; have a range of 3,500 nautical miles; and cruise at a height of 11 to 15 miles above the surface of the earth.

Such a supersonic jet should have the passenger-mile capacity of three present-day jets and the cost of its development should be somewhere in the region of £5 million to £7 million.

Design

Aeroplane design is getting rather like ladies' fashions: anything is possible. For instance, what could be more unusual than the Short SC-1 vertical take-off aircraft, a development of the Rolls-Royce "Flying Bedstead," or the Fairey "Rotodyne" vertical take-off airliner, a visitor from outer space if ever there was one; or the Saunders-Roe SR-N1 "Hovercraft," a carousel without horses. Then there are the attempts made at the age-old problems of man-powered flight, the best publicised being the ornithopter (flapping wing aeroplane) built by Emiel Hartman, who is now busy putting it through its paces. Other man-powered flight planes are the fixed-wing ones designed by T. R. F. Nonweiler of Queen's University, Belfast, which gets its power from two bicyclists inside the fuselage, and the inflatable wing, pedal-powered design of D. Perkins, a senior experimental officer at the Ministry of Aviation.

Flying saucers came into the news again when A. V. Roe (Canada) announced their Avrocar, a wingless aeroplane which uses a cushion of air formed by jets underneath its frame, rather like the Hovercraft and the Curtiss-Wright AirCar in the USA. Another approach is that of Boulton and Paul, who have done some work on a machine that uses a ducted fan to provide lift and control.

Fairly new, but quite conventional-looking, aircraft include the Vickers "Vanguard" turboprop airliner, a workmanlike successor to the "Viscount." Its double-bubble fuselage is of conventional construction, the lower part being used for freight. The wing torsion-box has three webs so arranged that the structure is fail-safe and capable of taking the load on two webs. The twin boom design of the Armstrong-Whitworth "Argosy," with its large freight doors fore and aft in the fuselage, is interesting. The company have developed a lightweight conveyor and pallet loading system which makes it possible for 4 men to handle the complete payload of 27,000 lb in 12 minutes. There are some novel design features in the Blackburn NA-39 high speed strike aircraft, designed for low level flight to avoid radar detection. The plane carries special map-plotting equipment and has full-span blown wing slots just after of the leading edge. The lift coefficient is claimed to be the highest yet obtained from a fixed wing surface.

Partly because it is Russian, and partly because it is the world's biggest airliner, with a maximum take-off weight of 414,000 lb, the Tupolev TU-114 creates a great deal of comment wherever it turns up. The French Sud-Aviation "Caravelle" bids fair to set a fashion in rear-fuselage mounted engines, for the style is being copied by two or three aeroplanes now in the embryo stage. The advantages claimed for such an installation include: improved passenger comfort, because there is less noise; greater aerodynamic efficiency, because a clean wing is possible with full-span slots and flaps; and safety in case of fire in an engine. One possible disadvantage is the absence of wing weight-relief from the engines.

There are many aeroplanes in various stages from the drawing board onwards. Of these, the Avro 748 is well forward and due to fly early this year. It is a short-medium range airliner with two Dart turboprops and room for 40 passengers. A three jet airliner, the Airco DH 121, is to be made by the de Havilland, Hunting Aircraft and Fairey Aviation consortium. It will have a cruising speed around 600 m.p.h. as a result of the Rolls-Royce RB 163 bypass engines, each of 10,000 lb static thrust, mounted at the tail, "Caravelle" fashion. It will carry up to 100 passengers for 1,200 miles. Entirely new techniques will have to be developed for the Bristol 188 welded stainless steel research aircraft, a single-seater twin-engine supersonic machine for speeds in the region of 1,500 m.p.h. It is being built to the order of the Ministry of Aviation in order that a study can be made of the problems of kinetic heating. The engines will be mounted in wing nacelles so that it will be easier to change over to different engines, if need be. Boundary control is being used on the US Lockheed "Hercules," a development of their C-130B transport. It has two outboard auxiliary turbojet engine pods at the wing tips for generating high energy air for ducting over the flaps, ailerons and tail surfaces. Designed as an airliner for BOAC and due to fly in 1961, the Vickers Armstrong VC 10 will have a cruising speed of 600 m.p.h. and non-stop Atlantic range. The four Rolls-Royce "Conways" giving 20,000 lb thrust each, are mounted at the rear end of the fuselage but the design philosophy of the machine is such that the high power will be used, not to give greater speed, but to improve runway performance. The plane has a swept-wing and a swept tailplane set high on a swept fin. Other machines that have only recently been announced are the Handley Page 115 and the Hawker P 1127, a VTOL strike fighter of advanced design.

In America, Convair, Douglas, Lockheed and North American have made many design studies, of which mention might be made of the Lockheed VTOL airliner to fly at 3,700 m.p.h. and Convair's delta wing design for a 2,000 m.p.h. airliner for the 1970's travelling at 80,000 ft.

No-Draught Fires

The joy of the coal fire has always been offset by the cold draught that so often accompanies it. Air is a necessity for combustion as many folk discovered when they carefully sealed doors and windows—and their fire went out. Still a blast of cold air around the feet is not pleasant and has been counted the curse of English homes for many years.

Vague attempts have been made at various times to get a supply of air for a fire that does not first whistle across the room. There is always one source available, except in those few cases where the floor is built direct on the ground, and that is from below the floor using the air bricks in the wall as the inlets. Of recent years several designs have been introduced to make use of this source and are now generally on the market. Three are shown in the illustrations here. All are designed to fit in standard fireplaces, either 16 in or 18 in width, and all can be fitted with back boilers for hot water supply.

The Bell Supaheat fire (on the left) has a duct that supplies both primary and secondary air. In the model 4D shown the air is led to a distribution chamber in front of the ash can; alternatively, a hollow below the hearth can be used for this purpose. Beneath the fire grate there is the ash can that is said to hold enough only to need emptying every four to six days, though this is dependant somewhat on fuel quality. It can be removed for emptying by first lifting out the grate. The fire front rises very little above the hearth but has a curved lip to prevent the ash from falling outwards. In front of it is a control knob for regulating the flow of primary air and therefore the burning rate. A banked fire with the flow cut off will last for 8 to 10 hours.

The smallest size, the 16 in, is recommended for heating rooms up to about 1,875 cu. ft and average consumption figures are given as 1¼ to 1½ cwt per week. At peak operation an output of 28,000 Btu per hour has been obtained. Other sizes are the 18 and 20 in, the latter being for rooms up to 2,900 cu. ft. A special model has been developed for use on an outside wall which will draw its air supply direct from outside and so can be used in rooms with solid floors. This model can also be arranged for emptying the ashcan outside. A convector unit is available to fit behind the fire as well as a back boiler, but the two cannot be used together. Accessories include sparkguards and fire guards.

The Dunsley unit in the centre is shown with a central heating boiler fitted at the back. It is claimed that such a boiler will heat up to four radiators around the house. In addition a domestic boiler can be fitted in the central rear space that will supply all normal hot water requirements. This arrangement could prove a very economical proposition and would have a certain inherent temperature regulation in that the fire would be stoked high in cold days and kept low on hot ones.

A large ash can is fitted that should not require emptying more than every five or six days but again this would inevitably be dependant on the fuel used. A depth of 12½ in is required to accommodate the ashcan and the air supply chamber. Control of the primary air to the fire is by a lever projecting from the front below the fret which operates a damper in the inlet pipe. The fret rises 5½ in above the hearth level and is freestanding.

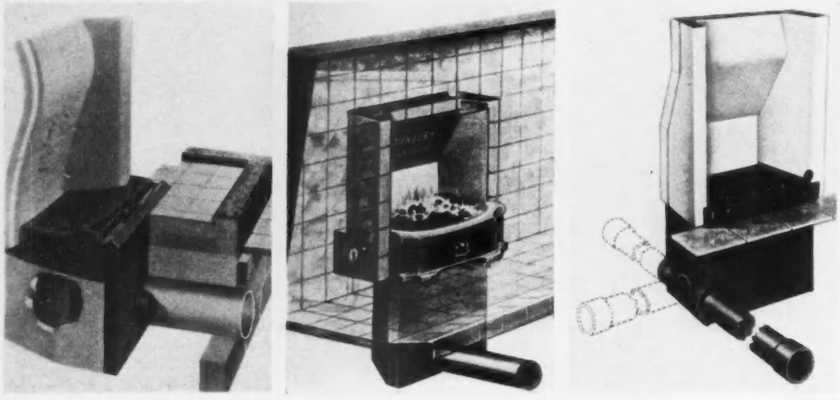
The fire basket slopes upwards from front to back and is deep enough to enable all solid fuels including smokeless to be used. The fire can be banked up for overnight burning by using small coal or slack. It is claimed that the rather higher fret improves the chimney draught but is not too high to spoil the radiation into the room.

The third unit illustrated is the Swinton. As with the Dunsley only the primary air is drawn from below the floor but the damper is a sliding plate fitted above the inlet in the ashcan chamber. This latter is reversible so that there are six possible positions for the inlet pipe, to take advantage of the underfloor configuration The same depth of pit (12¼ in) is needed so that in general like the other two it would not be possible to fit the fire in an upper room.

The standard model will heat rooms up to 2,100 cu. ft and has a firebox capacity of 0·55 cu. ft when the reeded front is used. An extension plate brings this up to 0·70 cu. ft for safe long period burning. If the reeded front is not chosen, there are two other types one of which is illustrated. Both are lower and therefore bring the level of the fire nearer to that of the hearth, thereby improving general radiation in the room.

With the standard model a depth of 18 in is needed to fit a Forum back boiler. This is capable of supplying two or three radiators as well as an indirect cylinder to heat the domestic supply. The output is approximately 20,000 Btu per hour. Where the chimney breast is only 14 in deep, the Mark III sunken fire can be used with a cast iron boiler flue. The firebox capacity is less than the standard model, only 0·47 cu. ft with the reeded front, and the fire will heat rooms up to 1,750 cu. ft in size. The boiler flue will supply all normal domestic hot water demands and also a small radiator or towel rail.

There is one essential requirement for all fires of this type—there must be an adequate supply of air below the floor. Therefore the air bricks must be clear (and more important, must exist) and if the floor is not a hollow one, a pipe taken to the outside is the only possibility.



Three types of fire that draw their air from below floor level and so reduce room draughts. On the left, the Supaheat; centre the Dunsley; and right the Swinton.

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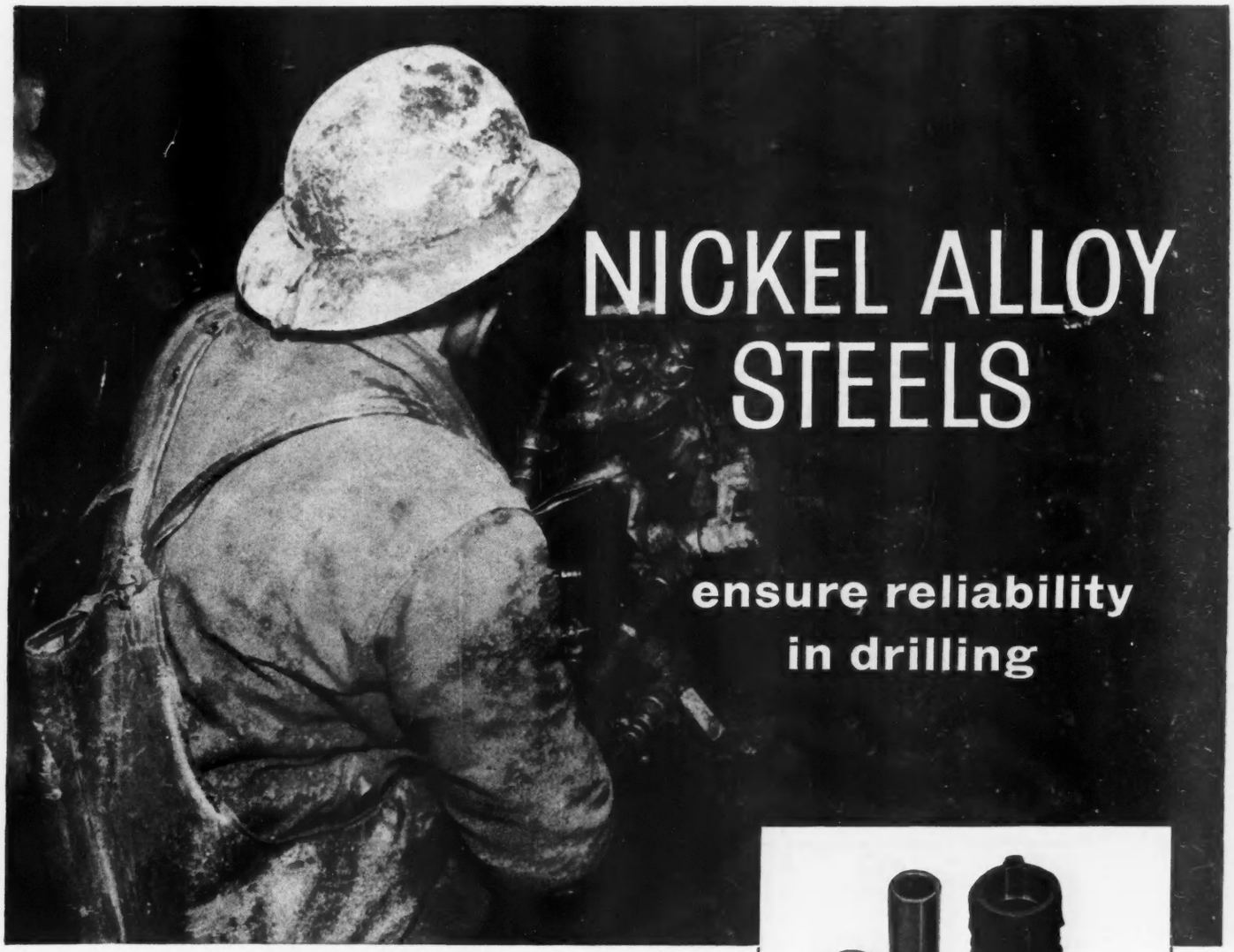

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Typical core mechanical properties of EN 33 are as follows:

SIZE	HEAT TREATMENT	MAXIMUM STRESS t.s.i.	ELONGATION per cent	IZOD ft. lb.
1½" dia.	Oil quenched 860°C Water quenched 760°C	52	20	63
3" dia.	Oil quenched 860°C Water quenched 760°C	42	24	88

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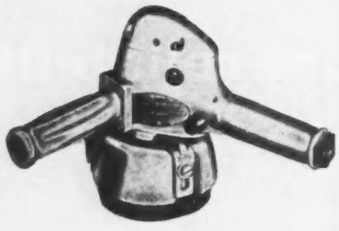

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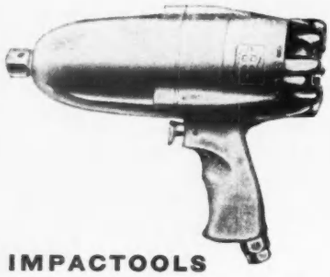

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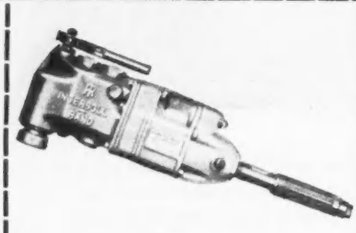
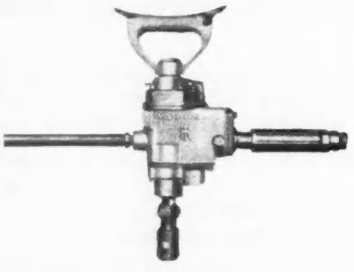
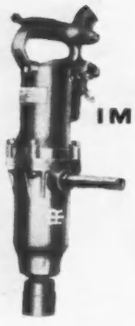


CLOSE QUARTER DRILLS

MULTI-VANE DRILLS





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SMALL MULTI-VANE DRILLS

P.3781

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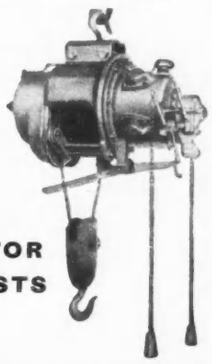

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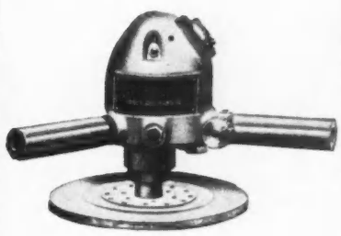

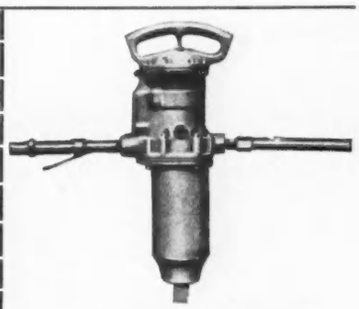

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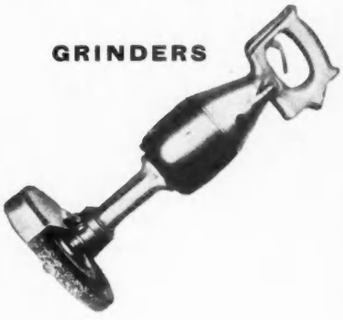

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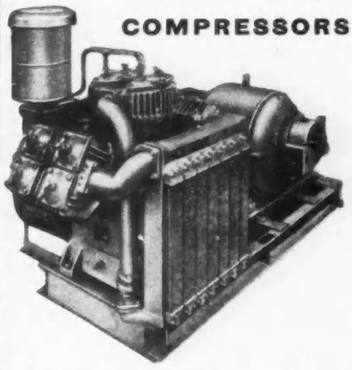

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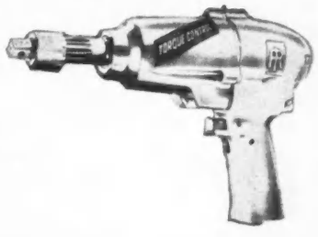

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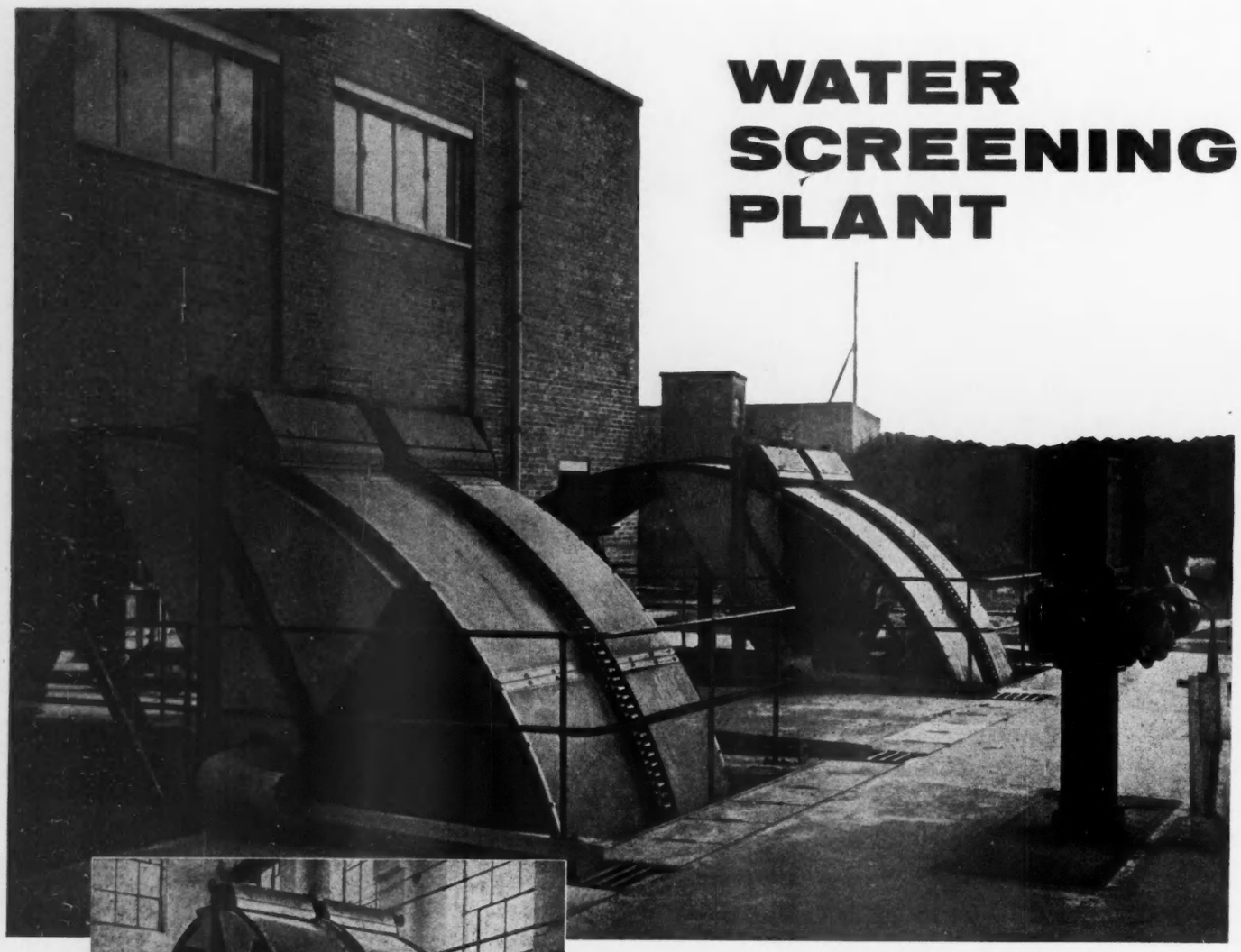

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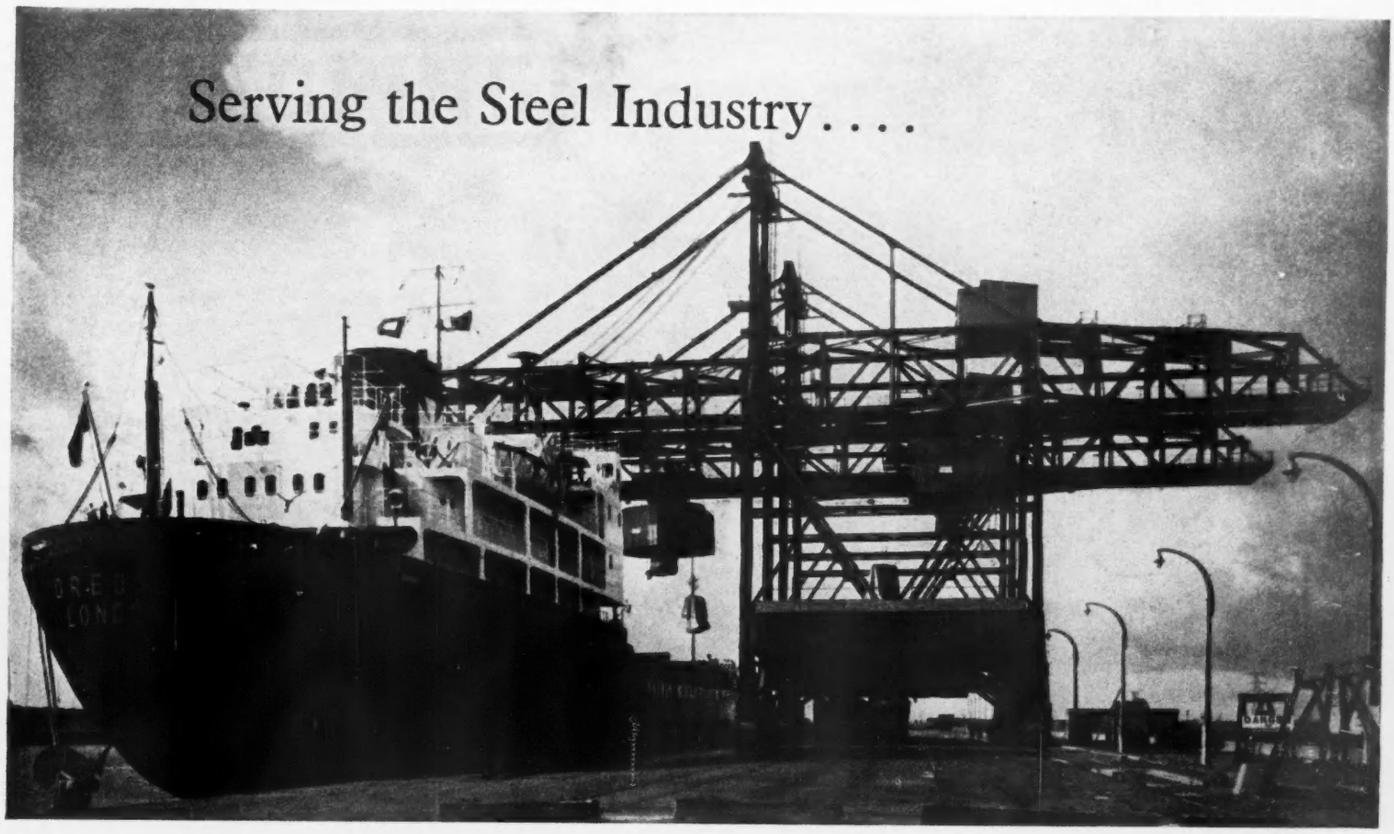

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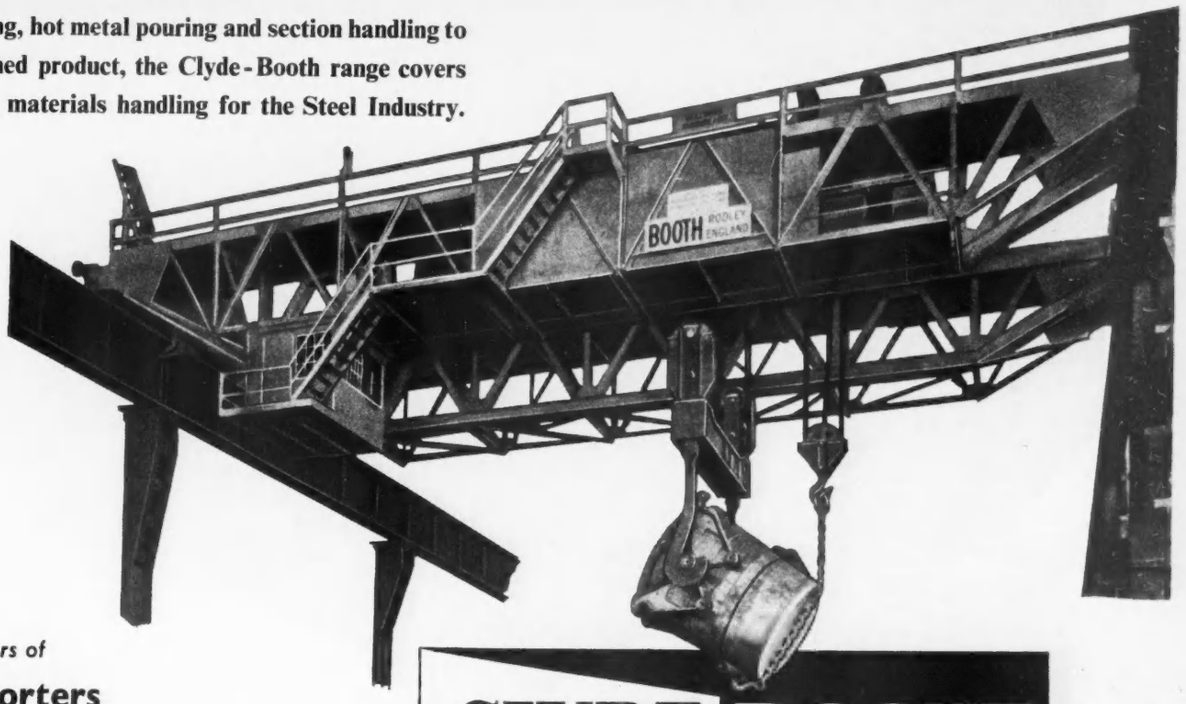

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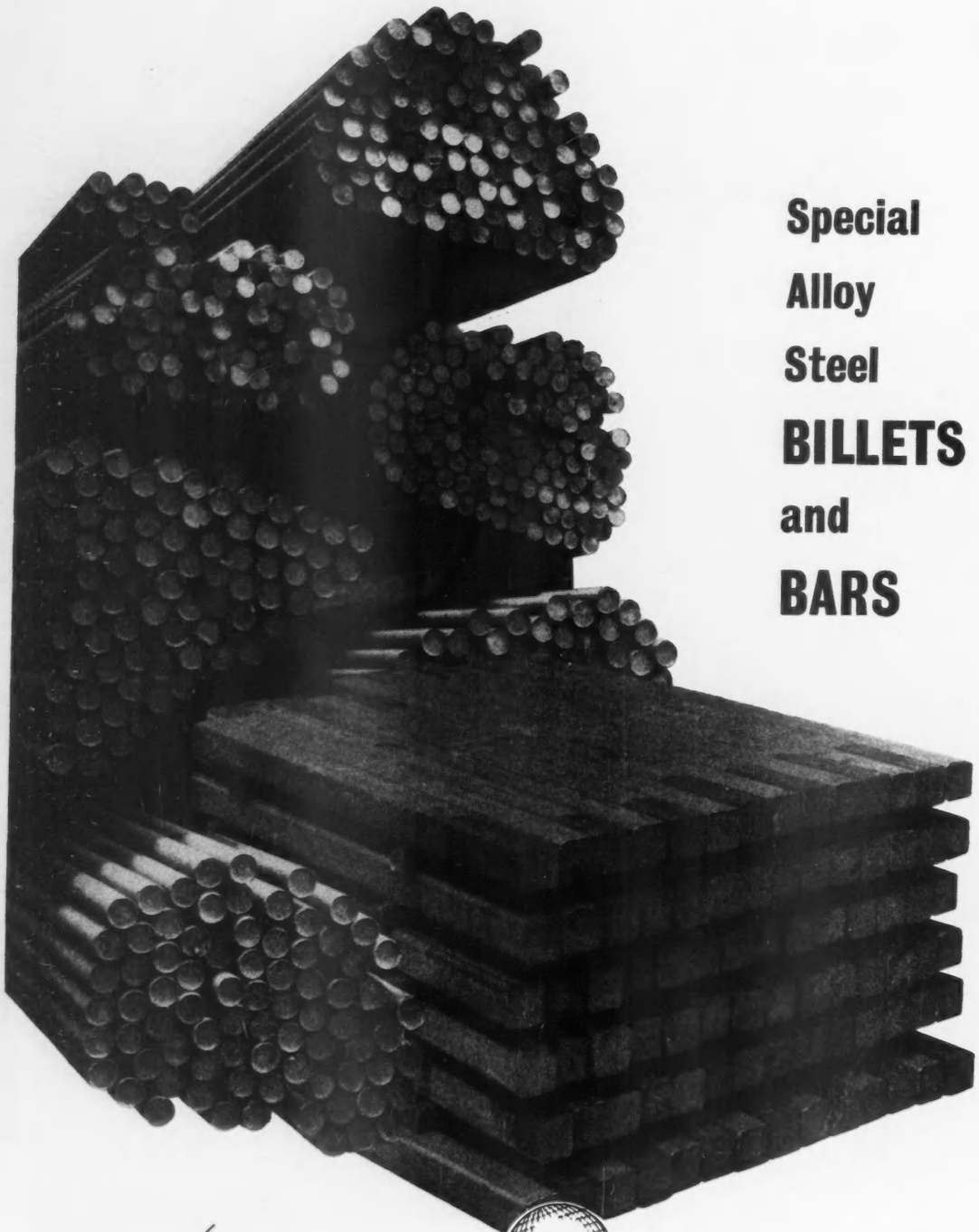

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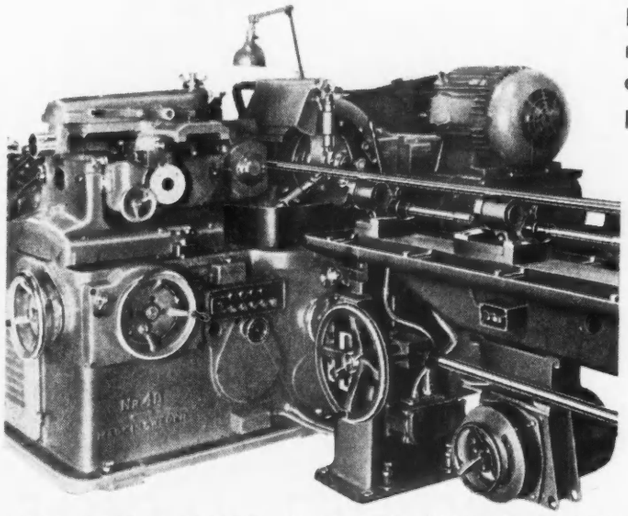

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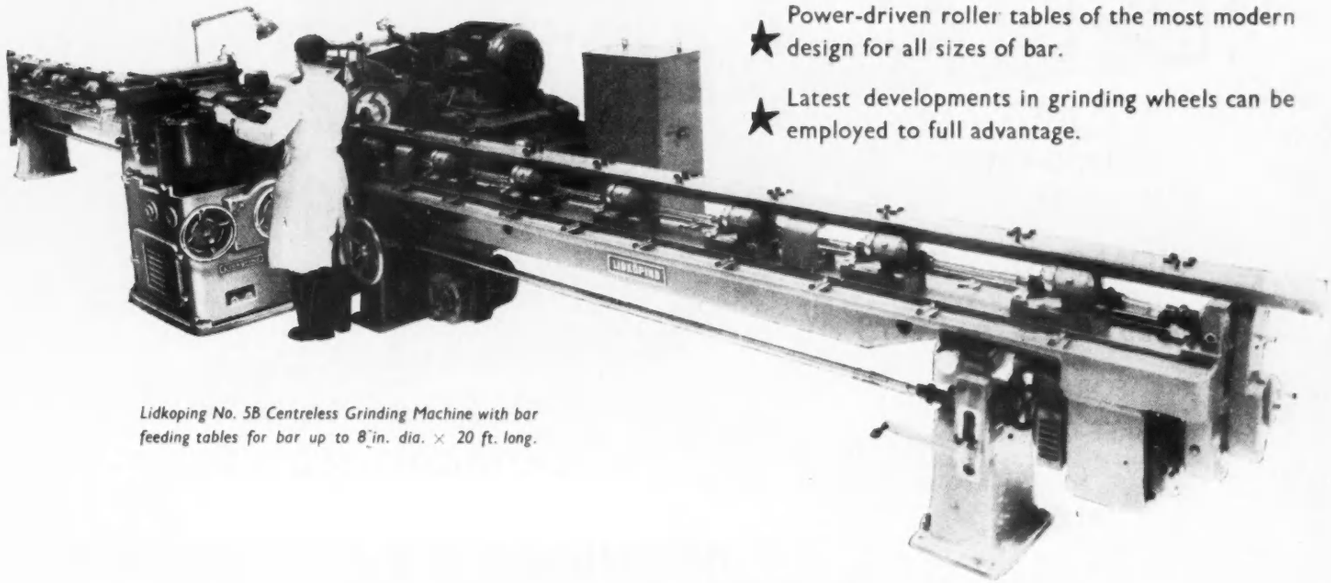

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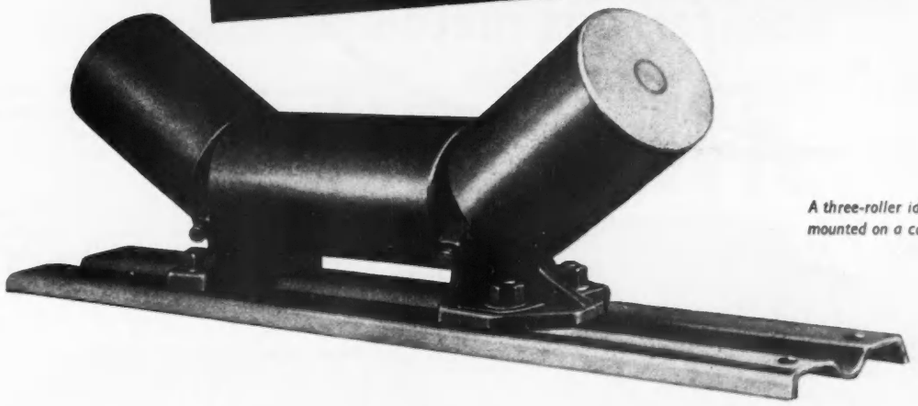

A three-roller idler mounted on a corrugated idler-board.

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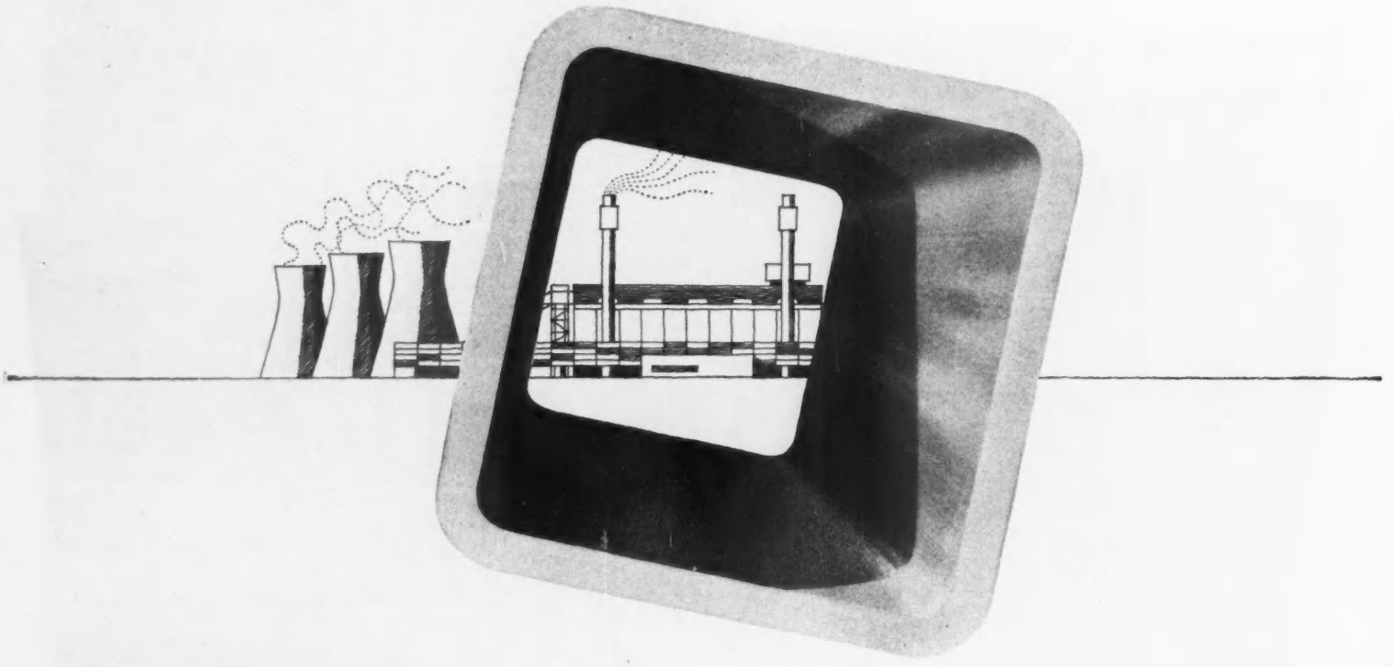

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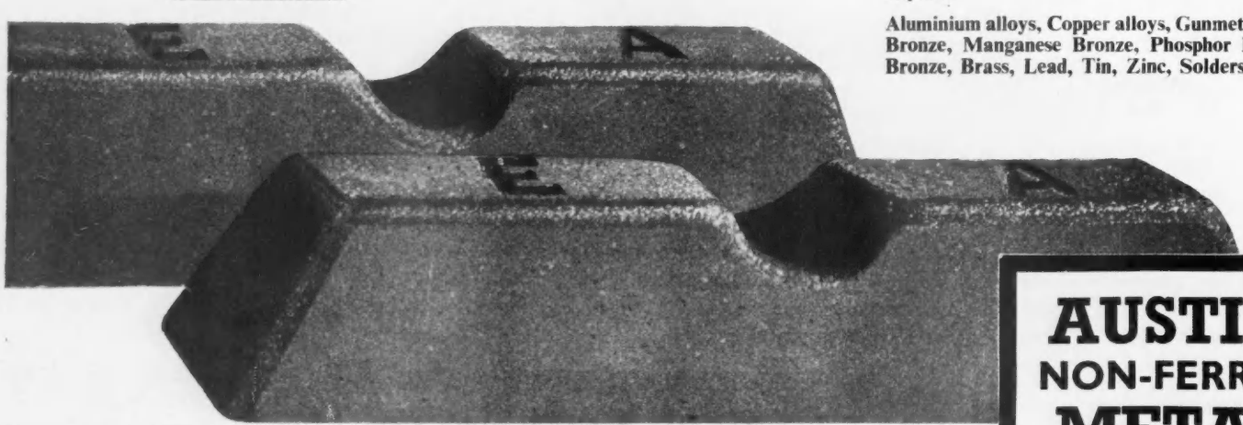

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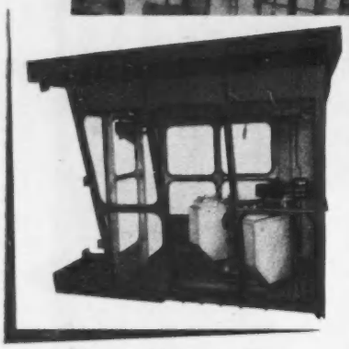

★ *a view of the cab showing the seat control unit.*

The Adamson 50/10 ton crane is the third of a series of new design supplied to Richard Thomas & Baldwins Limited, Ebbw Vale Section. Features of the crane include monolithic construction of the crab and the elimination of castings by mild steel fabrication of the hoist barrel and bottom block. The cab is of particular interest as it incorporates the most modern type of seat unit ensuring maximum visibility and ease of control. Joseph Adamson electric overhead travelling cranes can be supplied to all specifications including cranes suited to the most exacting 24 hours-a-day process work.

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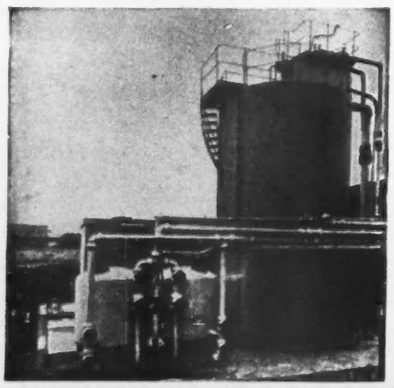

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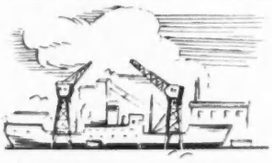

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SWITCH: The latest Reyrolle HH design rated at 60 amperes 550 volts and capable of making and breaking current-surges of up to 360 amperes at 0·3 P.F.

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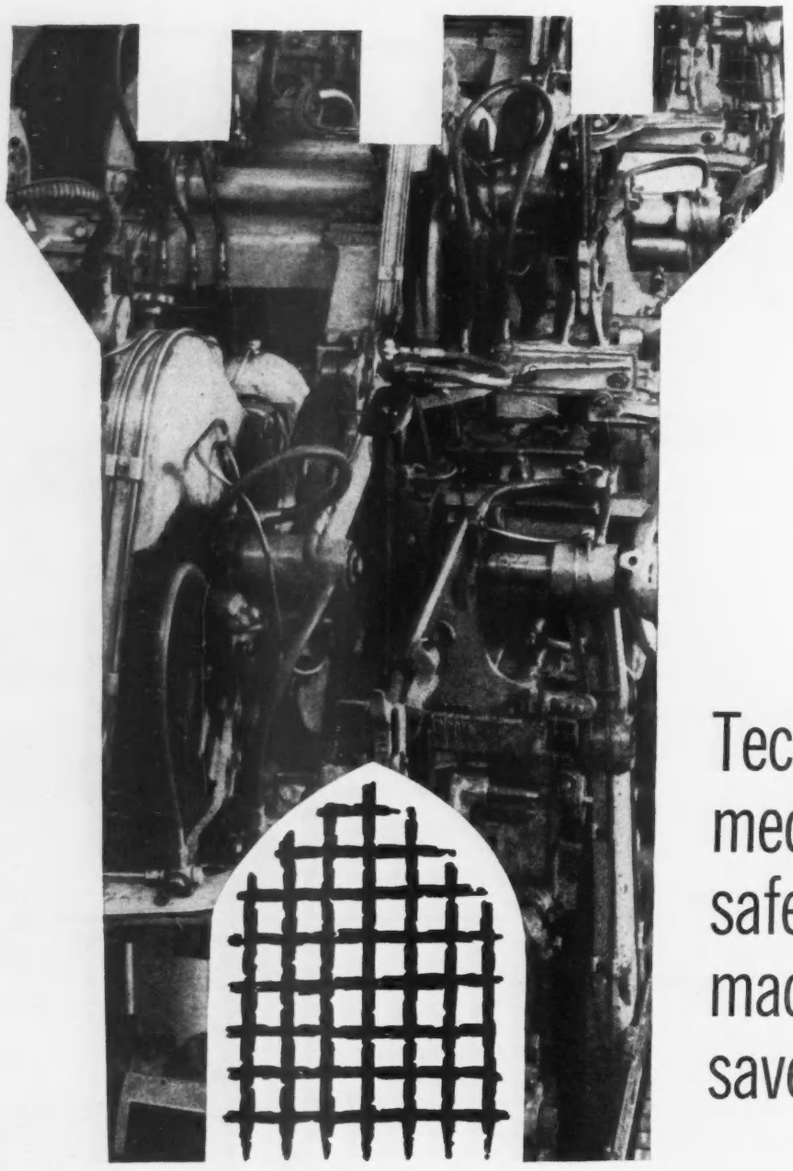

Tecalemit mechanical lubrication safeguards machinery and saves money

With Tecalemit Mechanical Grease Lubrication, every bearing gets exactly the right amount of grease at correct intervals. Machinery works better and lasts longer. Neglect and human error are eliminated.

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(There are also Tecalemit Mechanical Lubrication systems for use with every grade of lubricating oil.)

Tecalemit, the Authority on Lubrication, can solve *your* lubrication problem. Fill in this coupon and post it today. If you have a particular application or trouble-spot in mind, by all means enclose a note, a sketch or a drawing. You will be under no obligation whatsoever.

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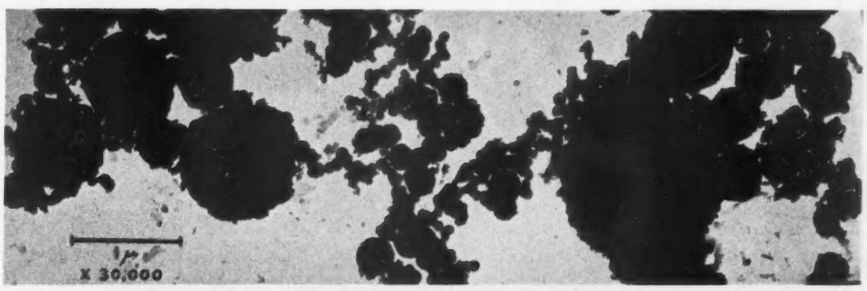
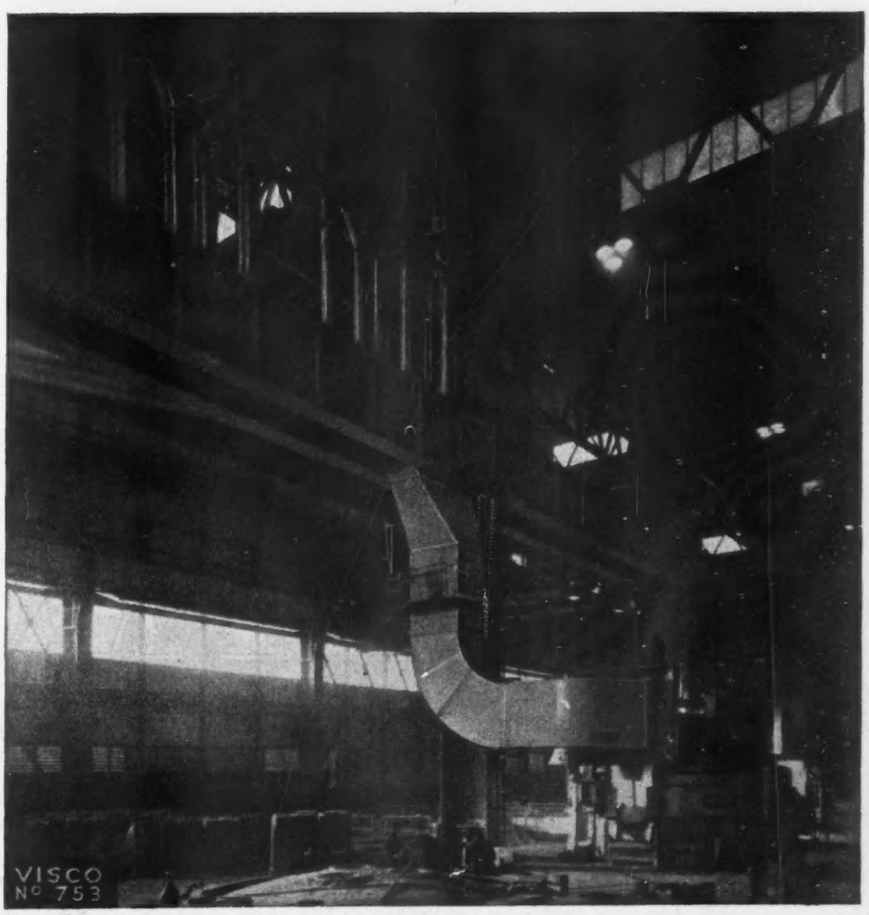


Micro photograph of dust particles collected by the 'Visco-Beth' Patent Automatic Dust Collectors installed at the works of Samuel Fox & Co. Ltd. The lower picture shows the arc furnace with fume and dust collecting ducting.



VISCO
ARC FURNACE
FUME & DUST REMOVAL

FWS

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Photograph by courtesy of Société Industrielle de l'Aluminium, Duffel, Belgium

Illustration shows a 32 in. two-high reversing hot breaking down mill for aluminium and light alloy slabs, which incorporates the latest developments

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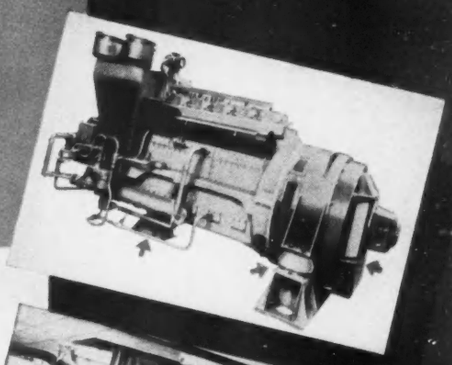

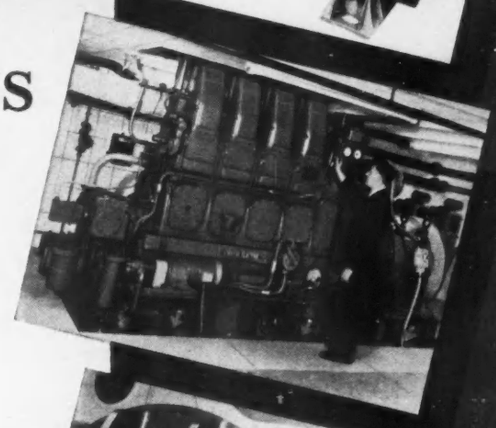

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Cushymounts, based on wide and intensive experience of vibration insulation, provide the large deflections essential for the successful isolation of low-frequency vibration from heavy machinery. A single Cushymount supports as much as five tons and can be adjusted to give any required deflection up to ¾" for loads of one to five tons.

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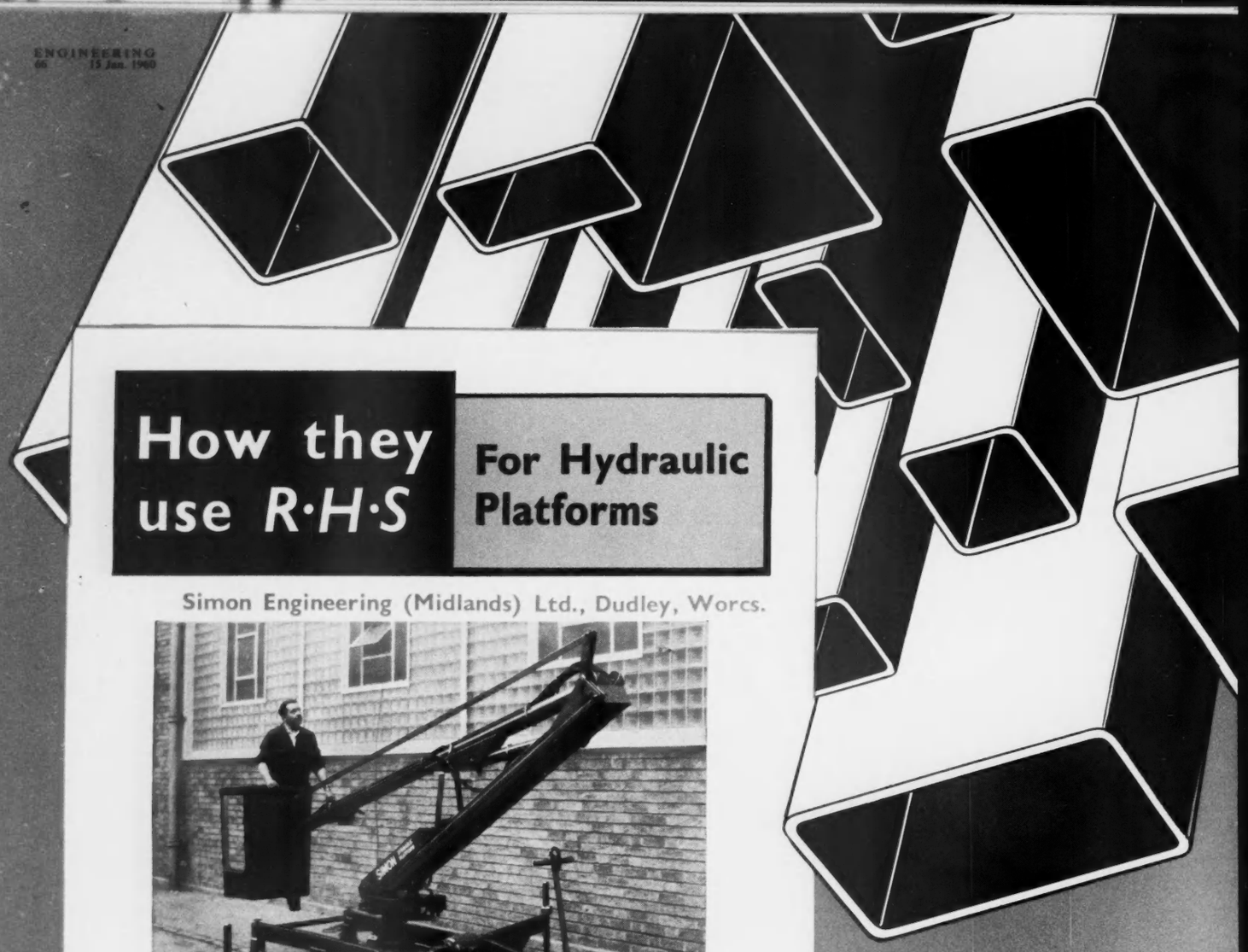
Cushymounts give the designer a complete mounting system. Despite their unusually high deflections no separate buffers or control links are needed, as movement in vertical and horizontal planes is limited to a pre-determined amount by positive means incorporated in the mountings. Cushymounts are, therefore, ideally suited to diesel locomotive engines and large generators for use on ships.

The illustrations on the right are: top, a Crossley generating set on three Cushymounts at the Dounreay Atomic Energy Establishment. Centre: 'English Electric' 4-cylinder diesel alternator on six Cushymounts and below: one of the three Cushymounts supporting the power unit on the Metropolitan-Vickers Bo-Bo locomotives for Eire.

METALASTIK



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This version of the well-known Simon Hydraulic Platform has a chassis frame mounting base made from 5″ x $2^1/_8$″ R.H.S. which give a very strong construction. The swivelling outriggers are of the same section, welded to double-depth near the hinge. The main boom is made from twin 5″ x $2^1/_8$″ R.H.S.

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R.H.S. are produced to the physical properties of B.S.1775 Grade 16.

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□ INCHES	▯ INCHES
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$1\frac{1}{4} \times 1\frac{1}{4}$	$3\frac{1}{2} \times 1\frac{1}{4}$
$1\frac{1}{2} \times 1\frac{1}{2}$	$3\frac{1}{2} \times 1\frac{1}{2}$
$2\frac{1}{2} \times 2\frac{1}{2}$	$4\frac{1}{2} \times 2\frac{1}{2}$
$2\frac{1}{2} \times 2\frac{1}{2}$	$1\frac{1}{2} \times {}^{13}/_{16}$
$2\frac{1}{2} \times 2\frac{1}{2}$	$2\frac{1}{2} \times 1$
$2\frac{1}{2} \times 2\frac{1}{2}$	$3\frac{1}{2} \times 1\frac{1}{2}$
$3\frac{1}{2} \times 3\frac{1}{2}$	$4 \times 1\frac{1}{2}$
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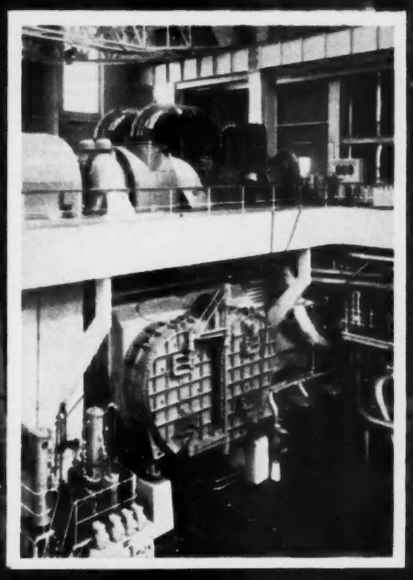

One of three PARSONS 60 MW turbo-generators and condensing plant at C.E.G.B. Tilbury Power Station.

✳ To obtain high overall thermal efficiency of a steam power plant a well designed and good performance condenser is necessary. Such large units are produced in considerable numbers at Parsons Heaton Works. A completed condenser with a cooling surface of 46,000 square feet is seen in the Condenser Shop ready to be dismantled and sent to site.

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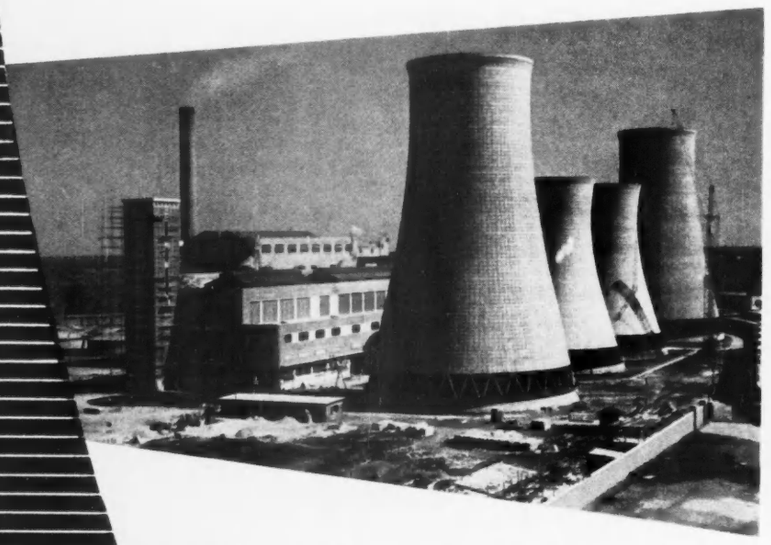

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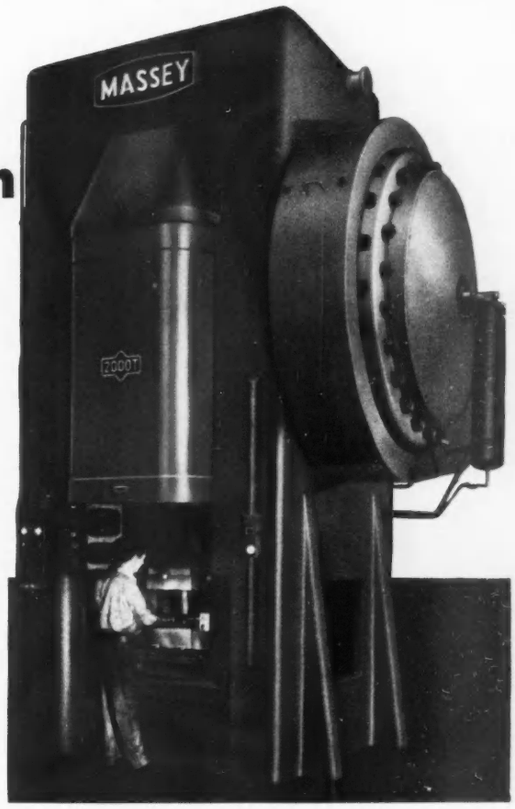

2,000 ton Forging Press. Messrs. Forging & Presswork Ltd., Birmingham.

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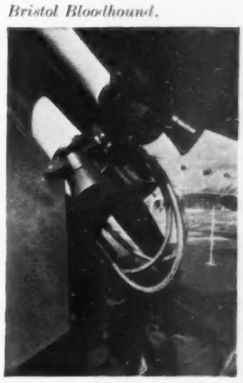

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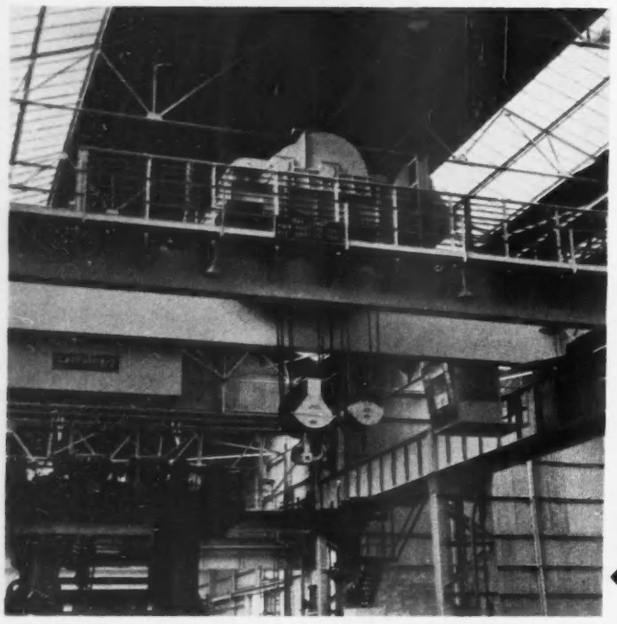

75 Ton Mill Bay Crane

50 Ton Goliath Crane 71′ span 71′ high

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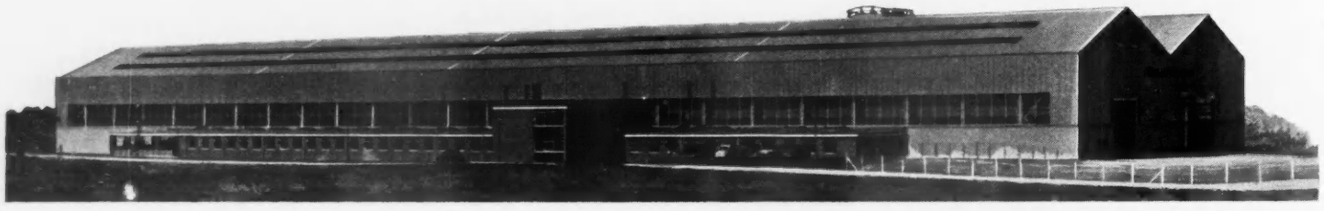

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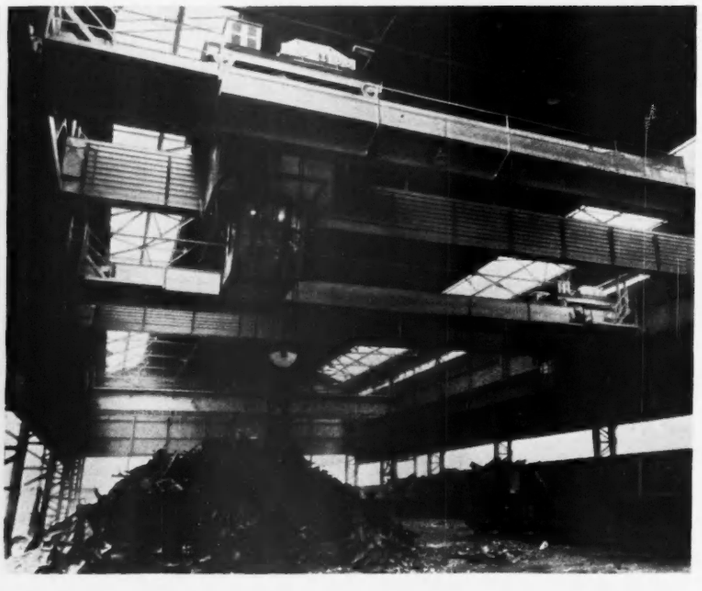

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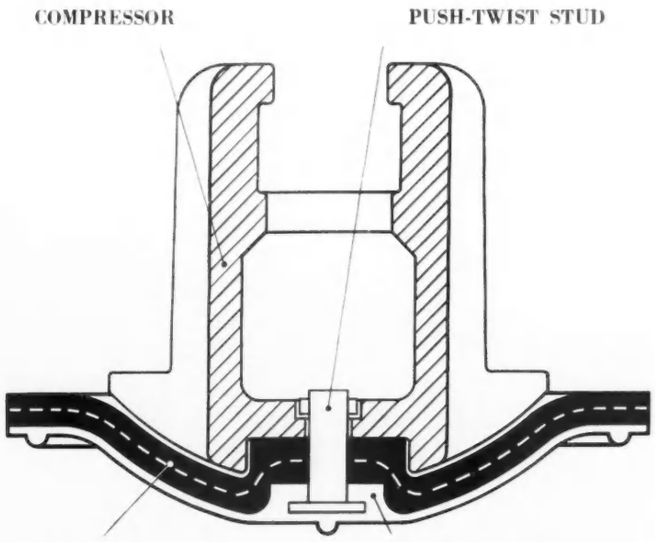
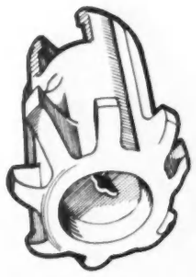
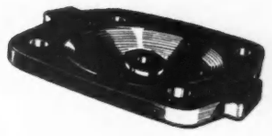
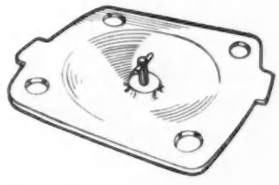




COMPRESSOR TO WHICH DIAPHRAGM AND BACKING ARE POSITIVELY SECURED.



SYNTHETIC RUBBER BACKING



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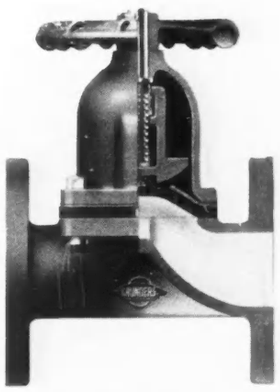

Section through typical Saunders Type 'A' Diaphragm Valve, illustrating robust glandless construction, isolation of mechanism and streamline passage.

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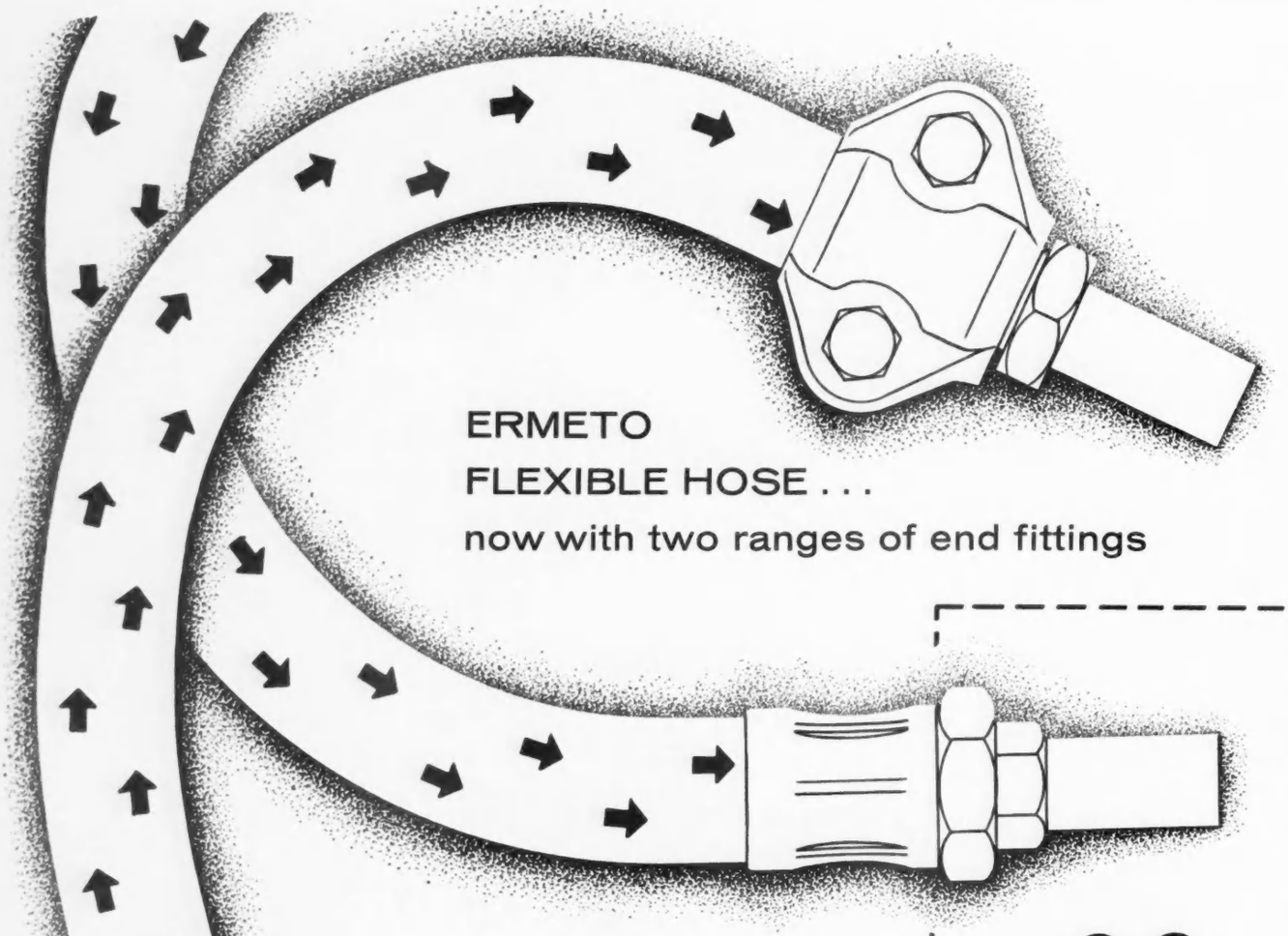

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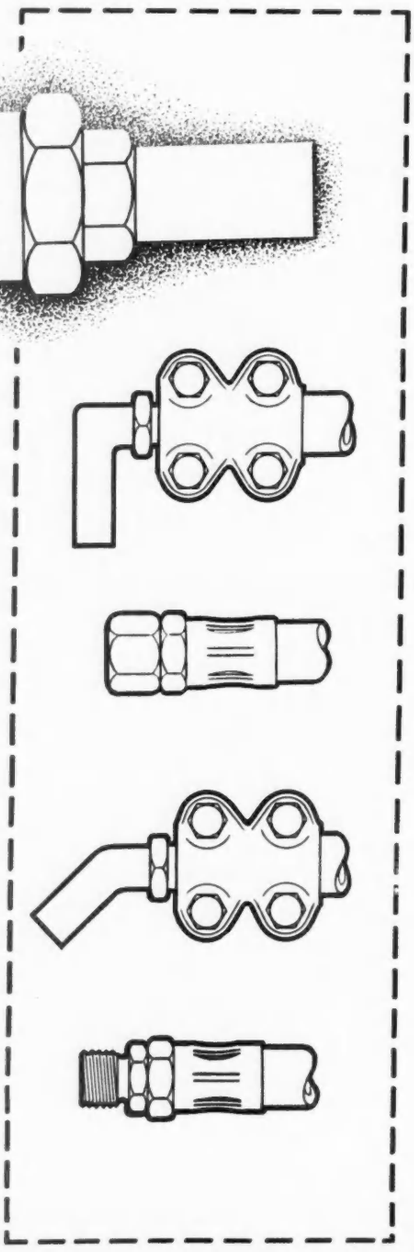

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who is the fourth man ?

A V.I.P. certainly, not present in person but very much in spirit. A man whom the other three have probably never met and may not even know. A man who is mostly out of sight but never, never out of mind. THEY are the Acheson heads of Sales, Production and Research. HE is a customer —you, perhaps—and at this conference the man of the moment. He knows us well, otherwise he would not be present (spiritually). He knows us well, yet almost certainly not well enough. He may not realise how much more we are prepared to do to help him. He knows we were the first and are the foremost manufacturers of colloidal graphite and MoS_2. He knows of "Oildag" colloidal graphite in oil and "Aquadag" colloidal graphite in water. But does he know about the scores of other Acheson dispersions, of silver, lead and boron, for instance, or vermiculite, glass and mica? Does he know that we have tailor-made, to the most stringent specifications, special dispersions for the UKAEA, Government and Service departments, and many world-famous industrial concerns? If he *does* know these things we apologise for this reminder. If he doesn't, we'll leave one final point with him: there's more in the Acheson service than meets the (regular or potential) customer's eye. Naturally we would be delighted to tell him about it.

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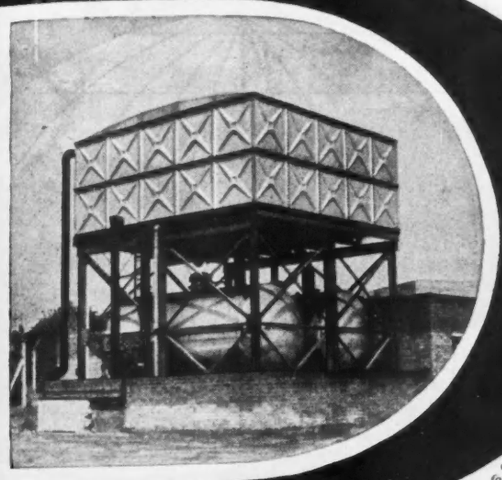
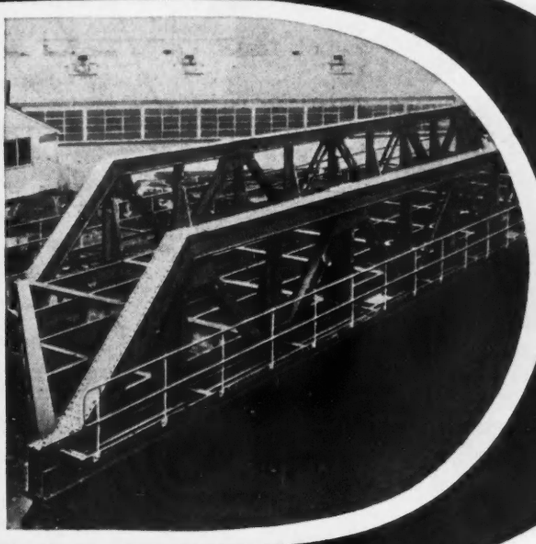


A galvanised pressed steel tank for the storage of over 19,000 gallons of cold water, supplied and erected for Bristol Siddeley Engines Limited for research and experimental duties.



A 100 ft. skew span road bridge with footpaths, assembled for works inspection.

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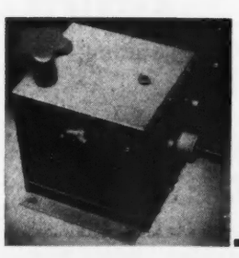

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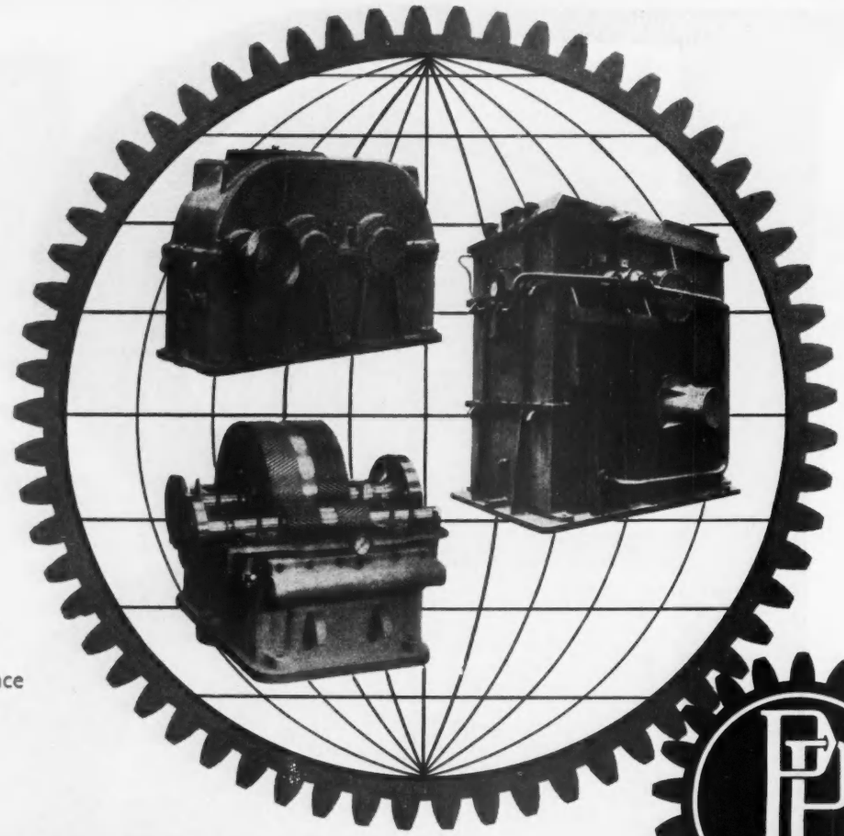

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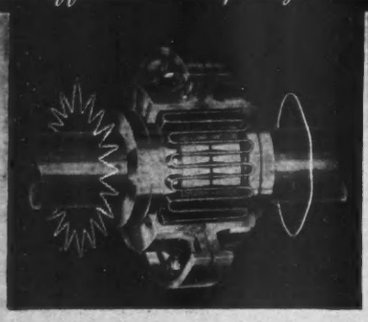

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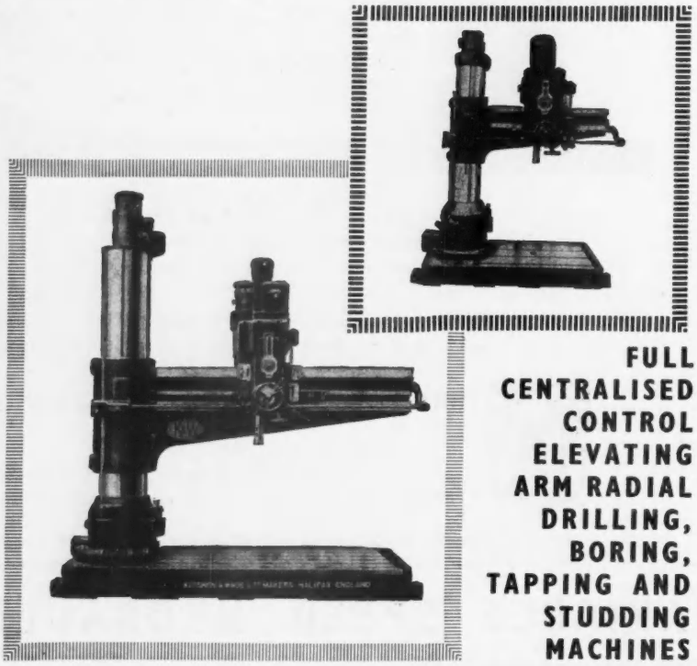

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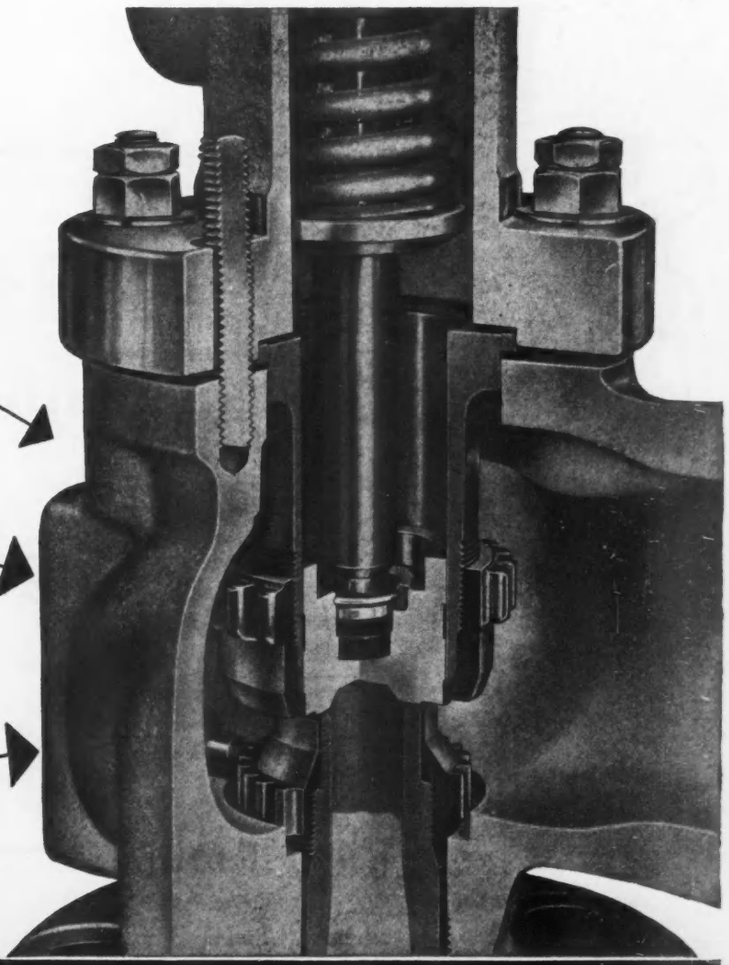

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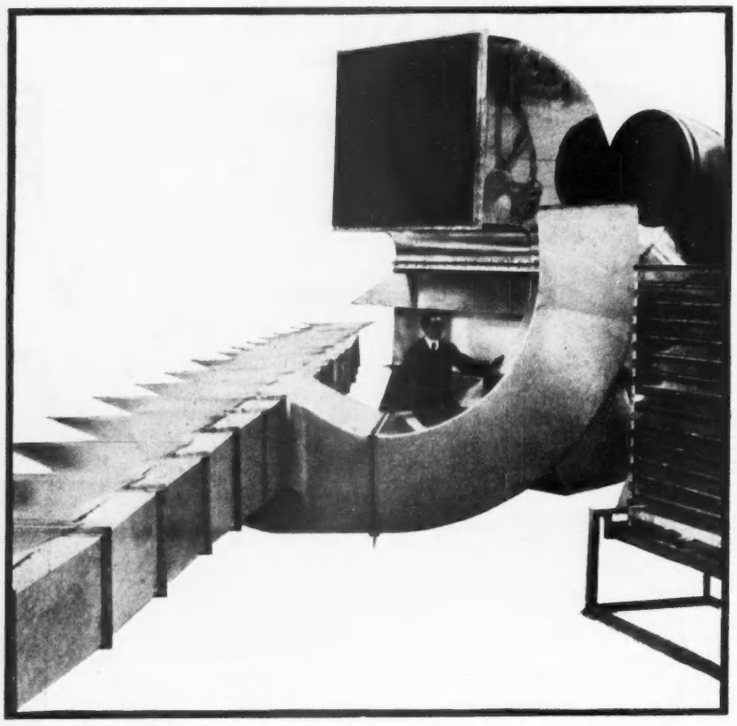

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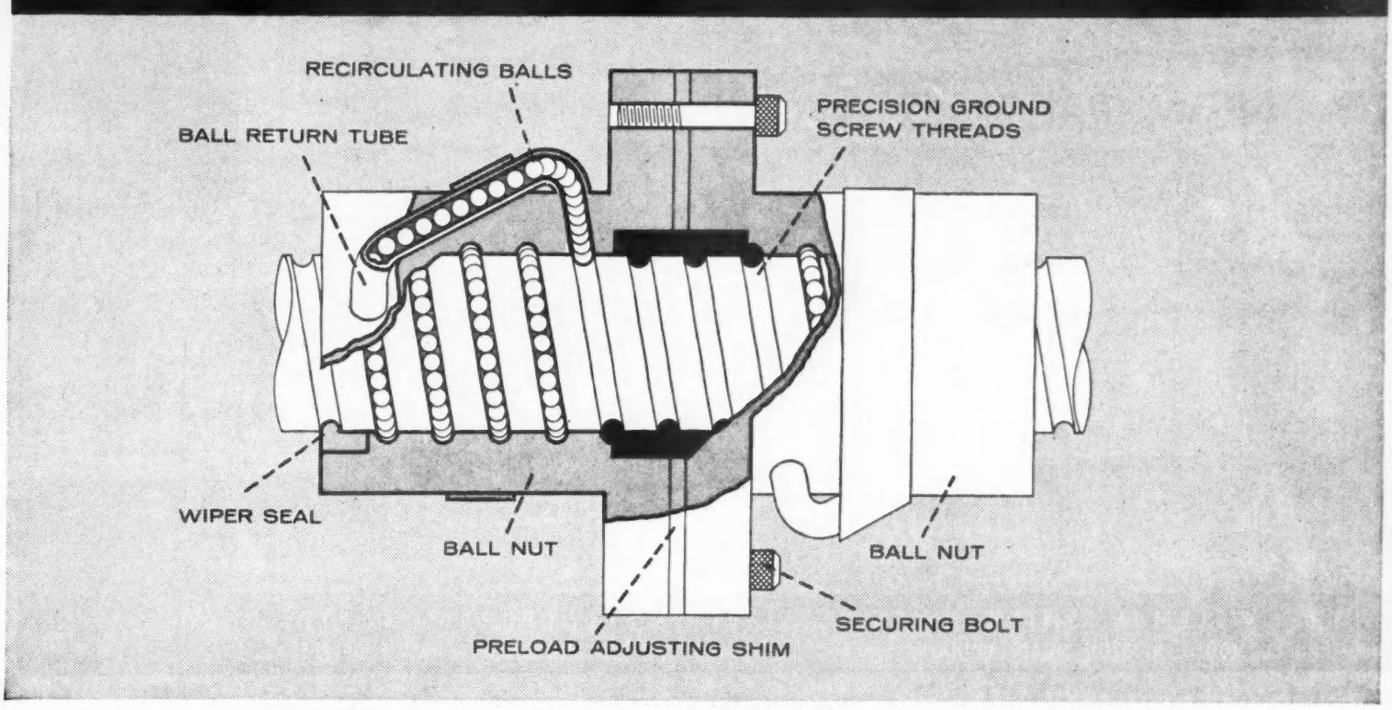

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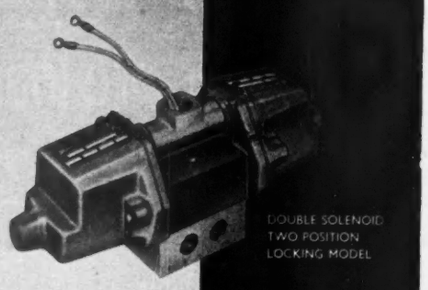

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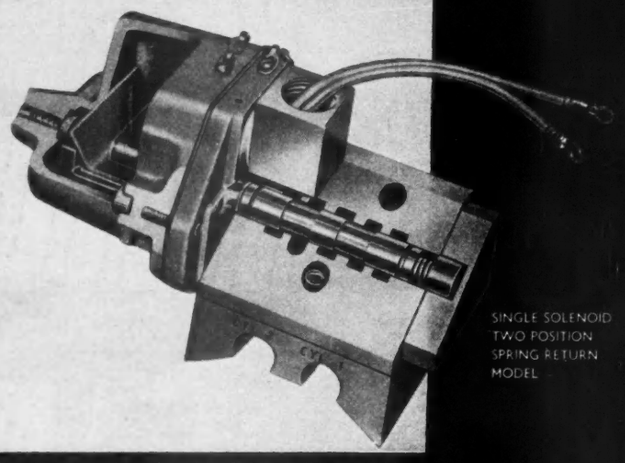

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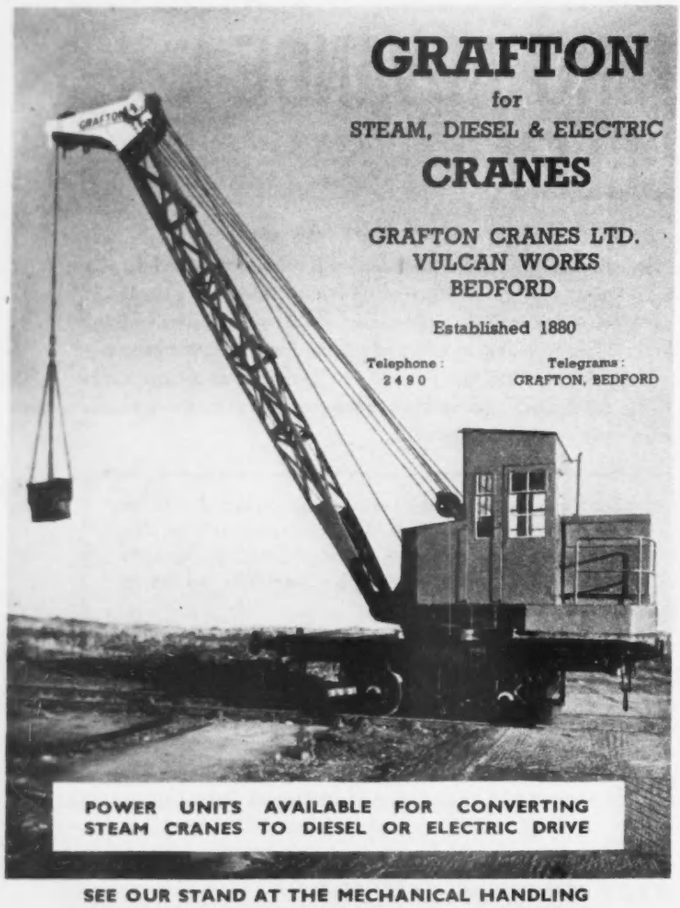

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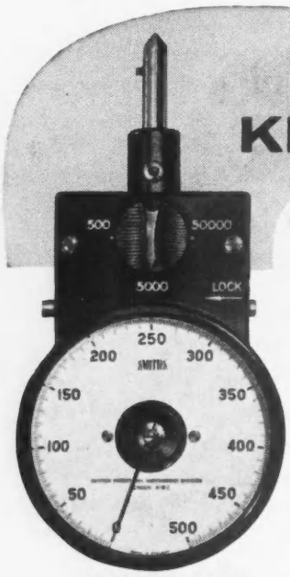

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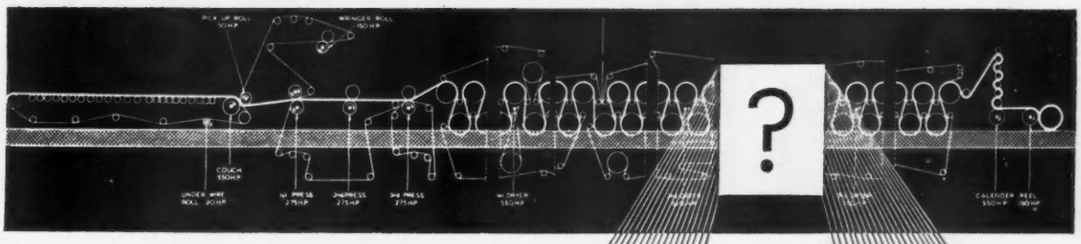

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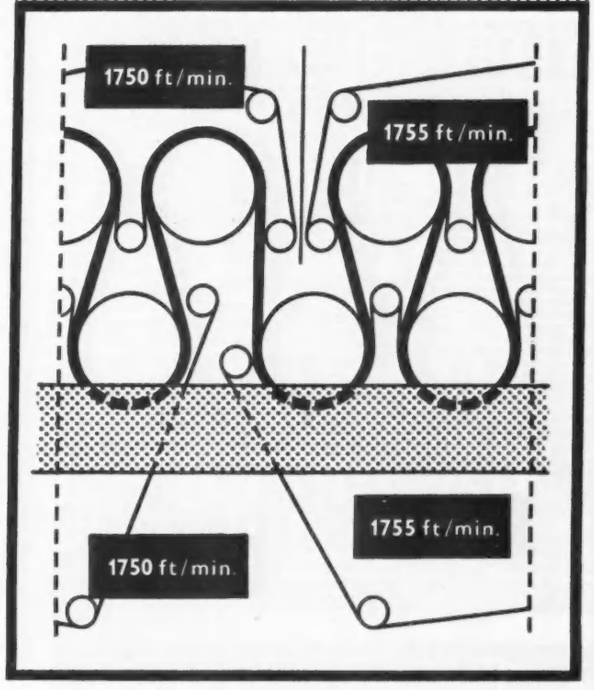

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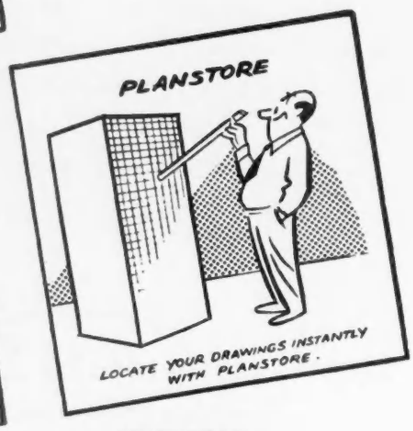

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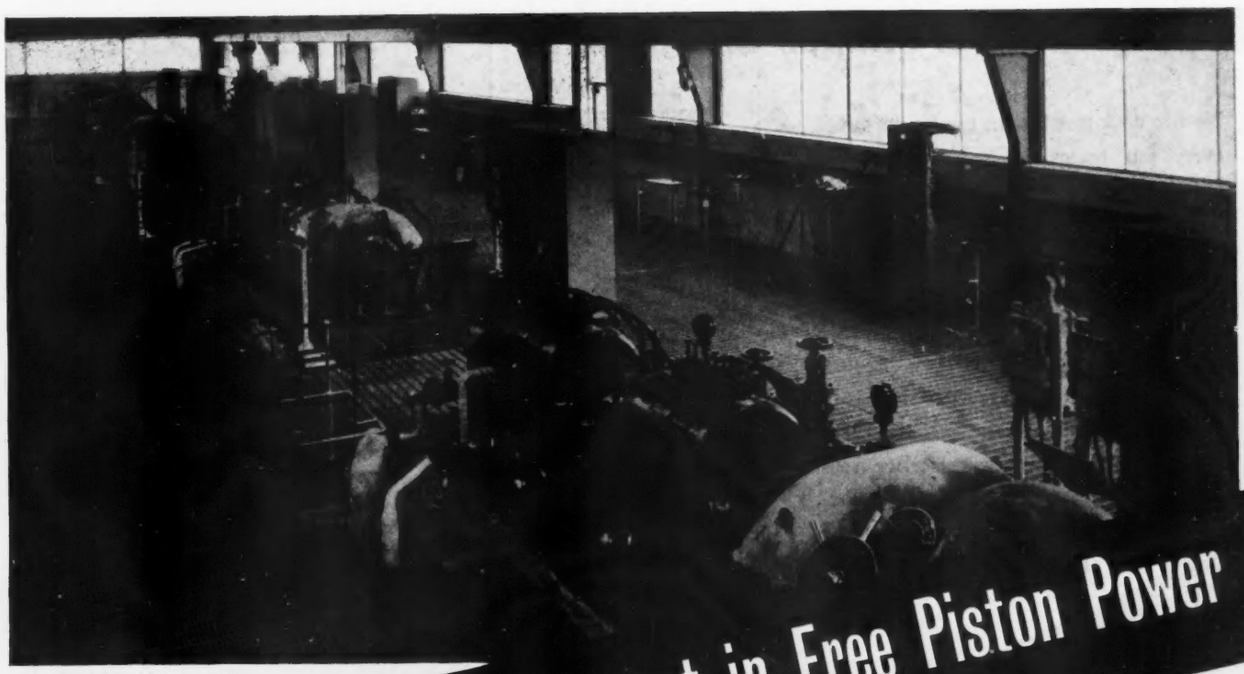

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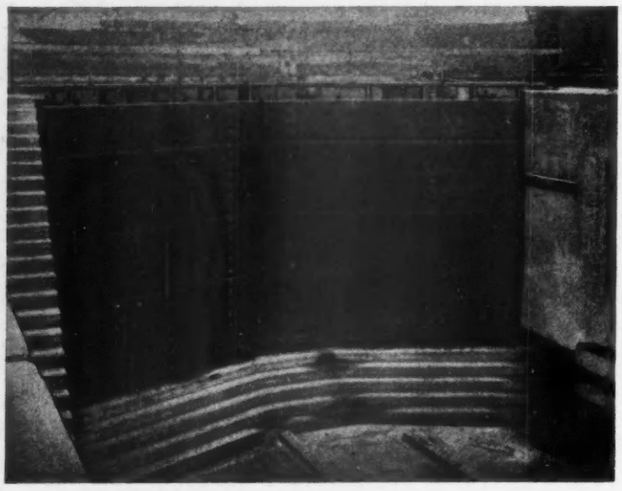

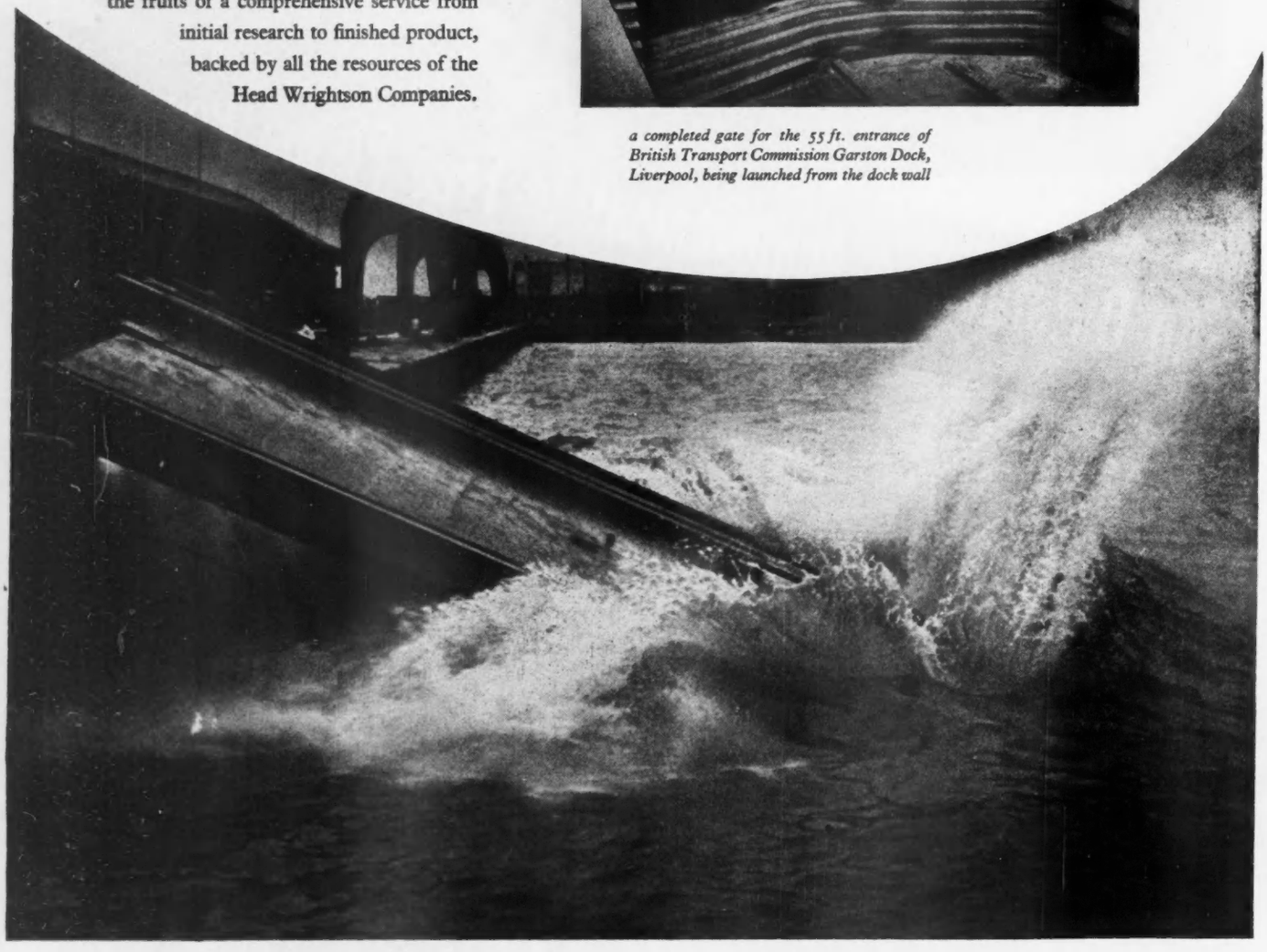

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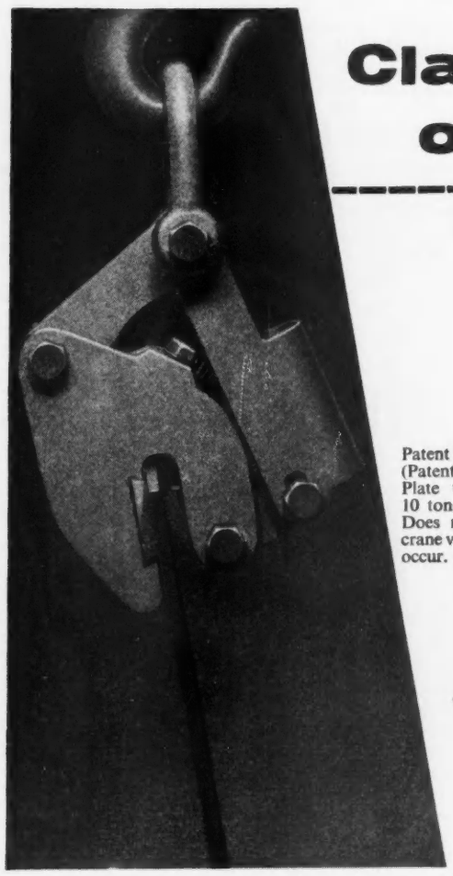

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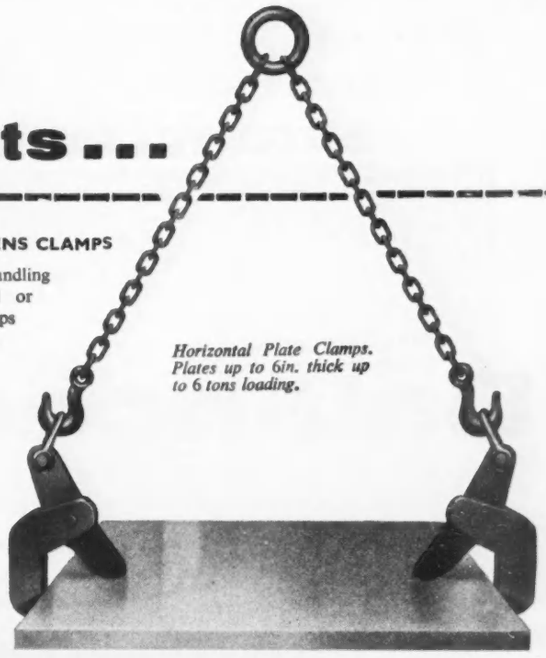

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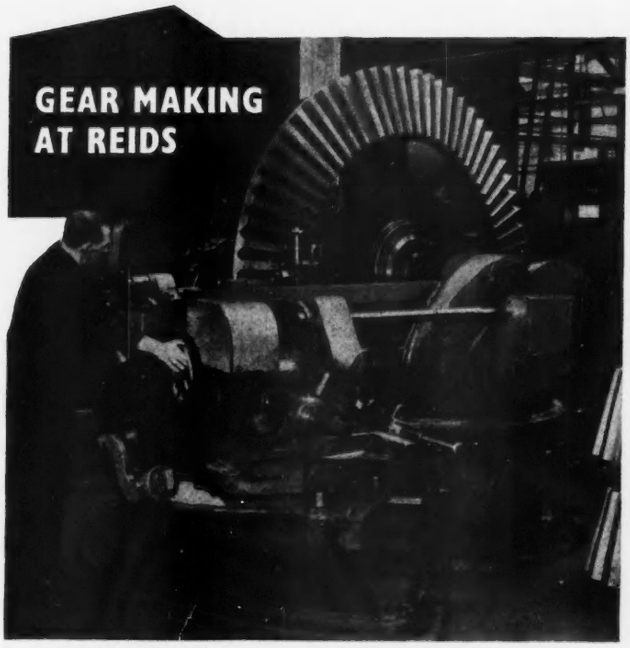

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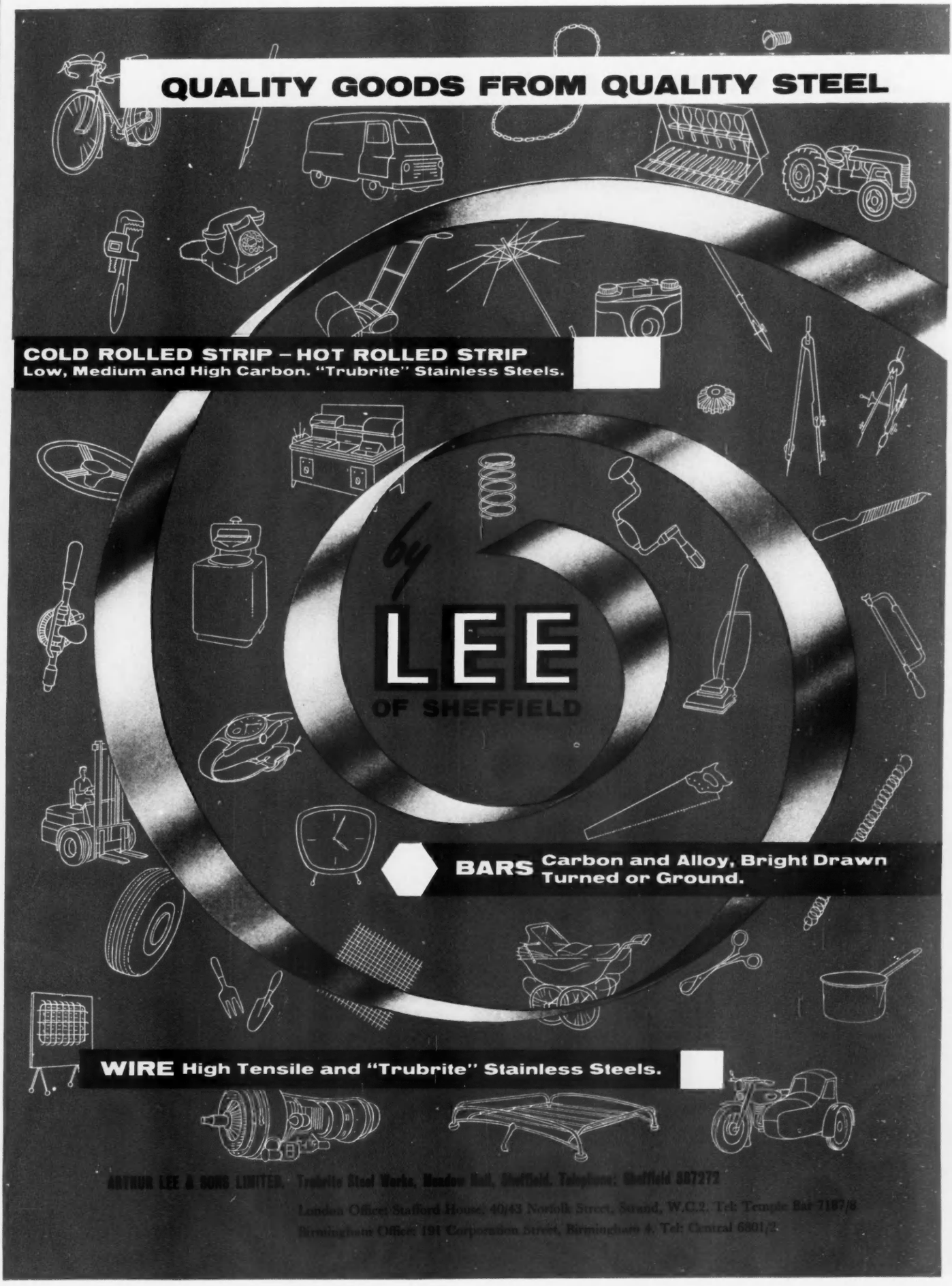
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